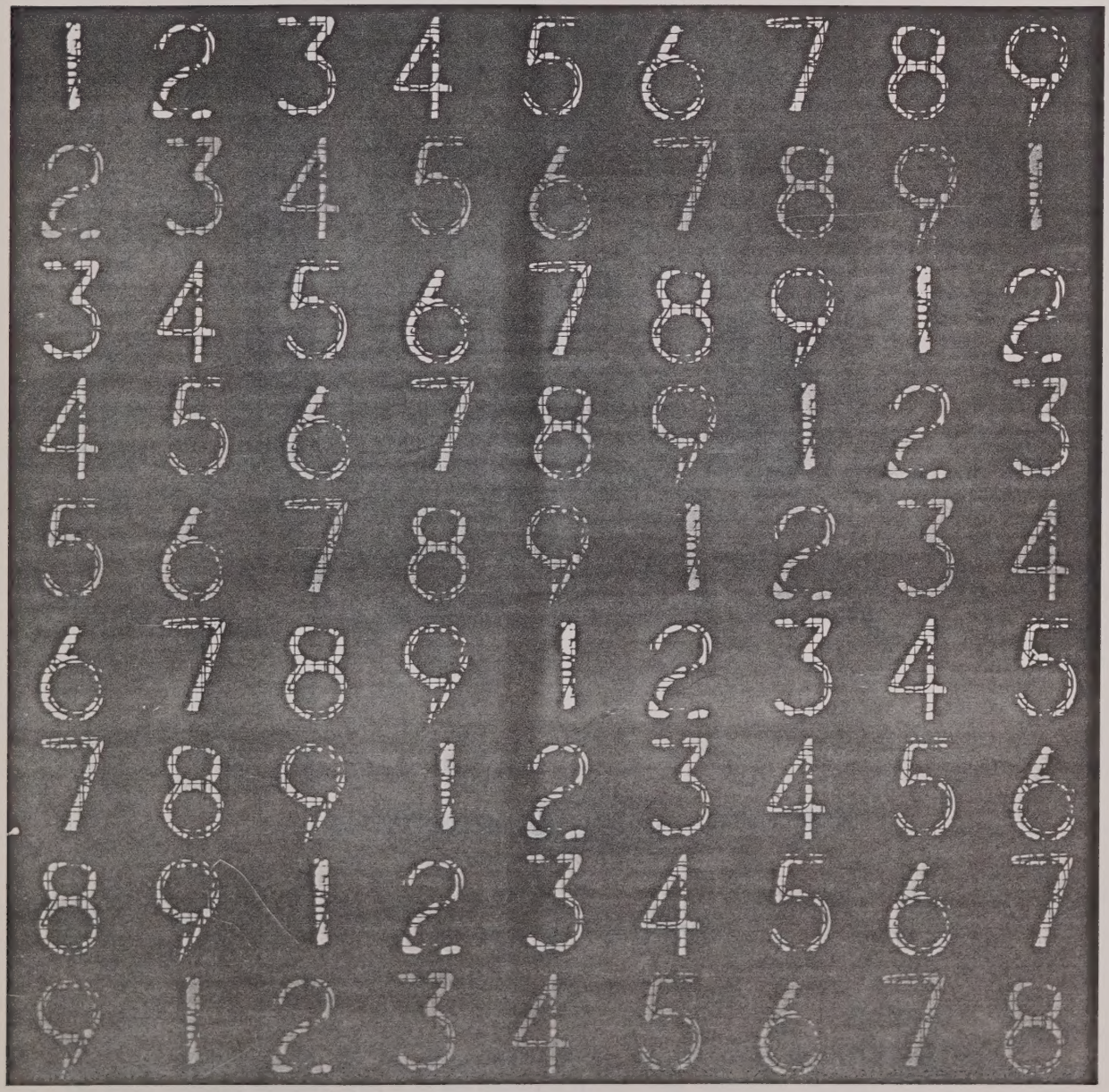
COUNTER / TIMER
INSTRUCTION MANUAL

GENERAL ELECTRIC
INSTRUMENTATION & COMMUNICATION
1200 KONA DRIVE
COMPTON, CA 90220
(213) 642-5317

SD 1936
True Integrating Digital Voltmeter



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SERIAL NO.

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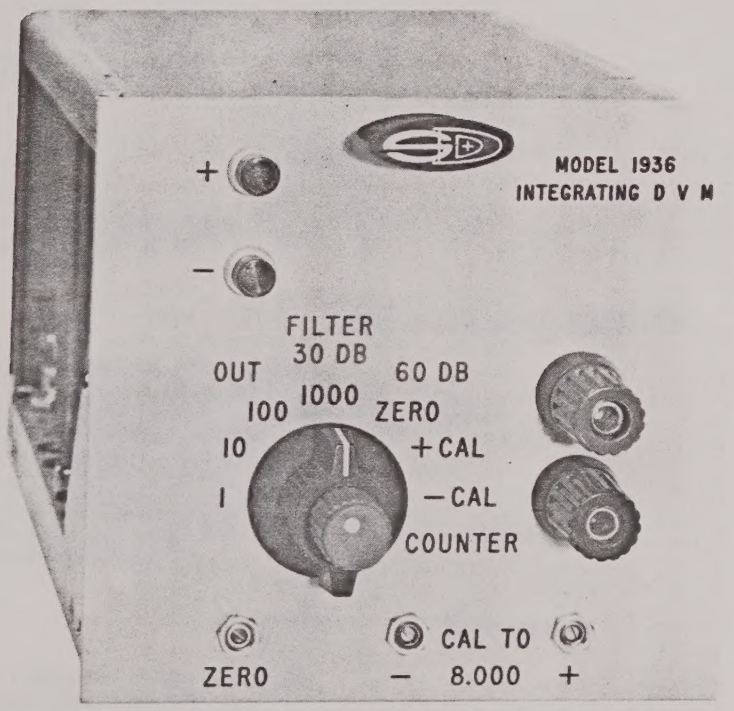
MODEL 1936
INTEGRATING DIGITAL VOLTMETER



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CHAPTER 1

GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. The Systron-Donner Model 1936 Integrating Digital Voltmeter (IDVM) is a plug-in unit designed to convert an S-D Model 1017, 1018, 1033, 1034, 1037, or 1038 electronic counter into a true integrating digital voltmeter. Measurements obtained using the Model 1936 IDVM are true average values, not functions of the instantaneous amplitude of the input waveform at two points in time, as is the case with linear-ramp type DVM's.

1-3. The S-D Model 1936 IDVM (figure 1-1) provides full scale sensitivities from ±1 volt to ±1000 volts in four ranges with 150% overrange capability on all ranges at no loss in percentage of accuracy. Accuracy of the Model 1936 is 0.025% of F.S. to 100% F.S. and 0.025% of reading to 150% F.S. The Model 1936 may be operated up to 300% overrange on all ranges except the 1000 volt range, with only slight reduction in measurement accuracy. A complete listing of Model 1936 operating specifications is presented in Table 1-1.

1-4. Because the noise content of some input signals may be sufficiently high to totally obliterate signal information content, the Model 1936 has been provided with a manually controllable input filter circuit. This filter circuit provides 0db, 30db, or 60db of AC rejection, (@ 60 Hz), allowing accurate measurement of signals with considerable noise content.

1-5. INSTRUMENT IDENTIFICATION

1-6. The Systron-Donner Model 1936 has a serial number located on a nameplate on the rear of the instrument. The serial number of your instrument should be included in the serial numbers listed on the title page of this manual. If the serial number of your instrument is not included in the list, there are differences between the instrument configuration covered in this manual and your instrument. These differences are described in supplemental data sheets provided with the manual.

Figure 1-1. Model 1936 Integrating Digital Voltmeter

Table 1-1. Specifications

Ranges: ±1, ±10, ±100, and ±1000 volts DC full scale (F.S.) with an automatically positioned decimal point when using a 0.1 second time base.

Range Selection: Manual.

Polarity Selection: Automatic with front panel indication.

Overrange: 150% within ±0.025% of reading and 300% within ±0.1% of reading (except 150% max. on 1000 v range).

Input Resistance: 10 MΩ or 1 MΩ/volt F.S. whichever is less.

Accuracy: ±0.025% F.S. within 24 hours of last front panel calibration and within 3 months of last internal reference calibration.

Temperature Coefficient: Less than ±0.003% F.S. per °C from 0° to 50°C.

Resolution: Determined by counter time base sitting:
0.001% F.S. for 1 sec time base
0.01% F.S. for 0.1 sec time base
0.1% F.S. for 0.01 sec time base

Calibration:
1) Individual calibration to internal references is provided on the front panel for + and - inputs (10 v range).
2) + and - internal references may be calibrated to an external standard.
3) Individual calibration adjustments are provided to equialize the 1 v, 100 v, and 1000 v ranges with the 10 v range.
4) Front panel zero adjustment is provided.

Input Filter (AC Rejection): Front panel switch positions for:
1) 60db at 60 Hz plus 12db/octave at higher frequencies.
2) 30db at 60 Hz plus 6db/octave at higher frequencies.
3) "OUT" — no filter.

Response Time: Less than 1 millisec to a step function to within 0.025% of final value (filter "OUT").

Sample Rate: Variable settings (determined by counter).

Compatibility with Counter: The Model 1936 is a standard plug-in for use in S-D Models 1037, 1038, 1017, 1018, 1034, and 1033 counters. Registration by in-line indicators on counter readout.

Weight: 2.5 lbs (1.1 kg) net; 5.5 lbs (2.5 kg) shipping.

CHAPTER 2

INSTALLATION

2-1. INITIAL INSPECTION

2-2. The Systron-Donner Model 1936 IDVM should be examined upon receipt, to verify that the instrument is intact, and as ordered. Inspect the IDVM for physical damage, such as scratched front panel, broken control knobs, or bent connector pins. If physical damage is evident, refer to the Systron-Donner warranty at the rear of this manual, and Paragraph 2-6 for repackaging and shipping instructions.

2-3. STORAGE AND RESHIPMENT

2-4. Temperature during storage and shipment should be limited as follows:

a. Maximum temperature 185°F (85°C).

b. Minimum temperature -69°F (-55°C).

2-5. To protect your instrument during shipment and storage, use the best packaging methods and materials available. Your Systron-Donner field office can provide materials similar to those used for original factory packaging. Contract packaging companies can provide dependable, custom packaging on short notice. Should packaging instructions be desired, however, the following guide can be of considerable value.

a. If possible, use original instrument container. If original container is not available, use a strong carton (350 psi bursting strength), or wooden box to house the instrument.

b. Wrap instrument in heavy paper or plastic before placing it in shipping container.

c. Use an excess of packing material around all sides of instrument, and protect instrument front panel with cardboard strips.

d. Seal packing container with strong tape or metal bands. Mark container with "DELICATE INSTRUMENT".

e. Refer to Systron-Donner warranty at the rear of this manual, and contact your Systron-Donner field office for shipping instructions. All correspondence concerning a Systron-Donner instrument should include instrument model number, part number, and serial number.

2-6. INSTALLATION

2-7. To install the Model 1936 IDVM plug-in in one of the Systron-Donner counter, perform the following steps:

Caution

Do not remove or install a plug-in unit in a Systron-Donner counter while power is applied to the unit. Removing or installing plug-in units while power is applied to the counter, can result in serious damage to both the counter and the plug-in.

a. Remove AC power from the counter.

b. Loosen counter panel lock on left side of plug-in compartment and remove blank filler panel, or installed plug-in from counter.

c. Install Model 1936 in plug-in compartment of counter, ensuring that plug-in rear connector is properly aligned with counter mating receptacle, then lock plug-in in place with panel lock.

d. Apply power to the counter.

NOTE

Systron-Donner counter should always be operated with a plug-in unit or blank filler panel installed in the plug-in compartment to ensure proper instrument cooling, and to satisfy interlock requirements of some instruments. Specific counter instruction manuals should be consulted for individual instrument requirements.

2-8. POWER REQUIREMENTS

2-9. All power required to operate the Model 1936 IDVM is supplied by the counter in which the IDVM is installed.

2-10. COOLING

2-11. The Model 1936 IDVM plug-in unit is cooled by the forced air ventilating system of the counter which is installed. There are no other special cooling requirements.

2-12. ELECTRICAL CONNECTORS

2-13. The red and black input terminals on the front panel of the Model 1936 plug-in (figure 3-1) provide the only signal connections to the unit. All other connections to the plug-in are made through the 50 pin connector mounted on the rear panel of the plug-in unit.

CHAPTER 3

OPERATION

3-1. INTRODUCTION

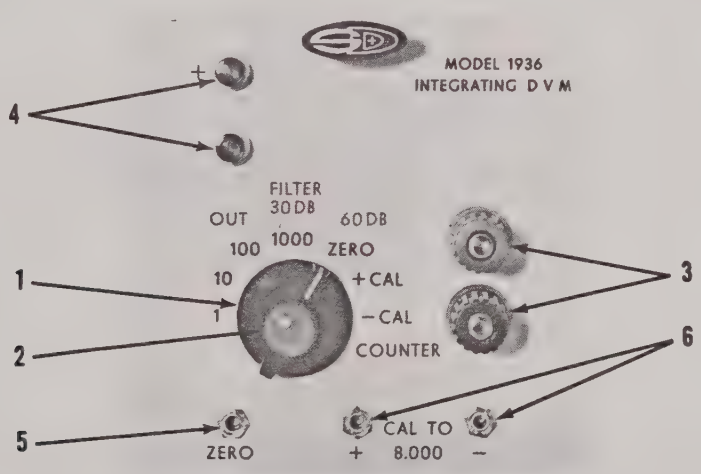
3-2. The Model 1936 Integrating Digital Voltmeter provides Models 1017, 1018, 1033, 1034, 1037, and 1038 Electronic Counters with DC voltage measurement capabilities. DC voltages from +1000 vdc to -1000 vdc can be measured accurately, using the four operating ranges of the Model 1936 (1 10, 100 and 1000 volts) in conjunction with the automatic polarity indicators. Overrange capability of the Model 1936 is 300% on all ranges except the 1000 volt range, where overrange is limited to 150%. This large overrange capability increases measurement accuracy in the 1 to 3 volt, 10 to 30 volt, and 100 to 300 volt ranges.

3-3. CONTROLS AND INDICATORS

3-4. Figure 3-1 provides a detailed description of the Model 1936 front and rear panel controls, connectors, and indicators.

3-5. OPERATING INSTRUCTIONS

3-6. Figure 3-2 provides step-by-step procedures for making DC voltage measurements using the Model 1936 IDVM plug-in installed in a Model 1037 counter. The operating procedure presented also applies to DC voltage measurements made with the Model 1936 installed in Models 1033, 1034, or 1038 counter, or in Model 1017 or 1018 frequency meters.



FRONT PANEL

1. Range Switch: An eight position rotary switch that selects one of four operating ranges (1, 10, 100, or 1000 vol s full scale), one of three calibration ranges (ZERO, +CAL, or -CAL), or an interlock (COUNTER) position which allows the counter to operate independently of the p.ug-in unit while t:e plug-in unit is installed.

2. FILTER Switch: A three position rotary switch that selects 30db or 60db of .nput AC rejection, or removes the AC filters from the input circuit.

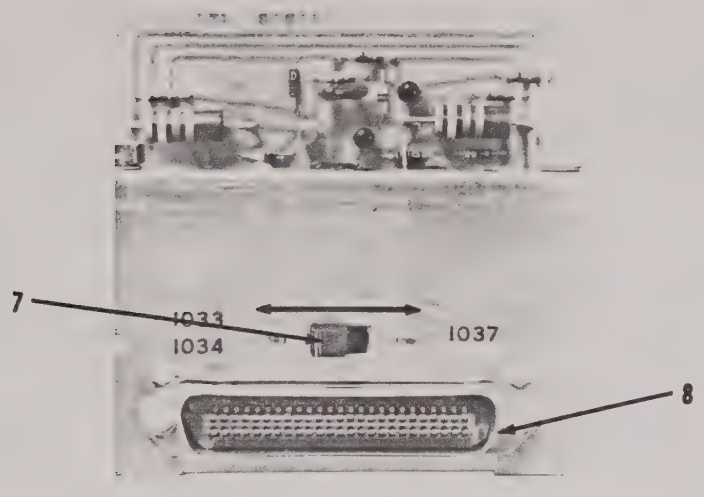
3. Input Signal Connector: Two binding posts to which input voltages are applied. Red binding post is signal input, b:ank binding post is chassis ground.

4. Polarity Indicators: Two neon bulbs that automatically indicate polarity of applied DC voltages.

5. ZERO Adjust: A screwdriver adjustment that sets IDVM output to the counter when IDVM input is grounded.

6. +CAL and -CAL Adjust: Screwdriver adjustments that control the IDVM s dynamic response to inputs of +8.000 vdc and -8.000 vdc respectively. The +8.000 and -8.000 volt levels are provided by precision voltage supplies within the IDVM.

Figure 3-1. Controls and Indicators (Sheet 1 of 2)



REAR PANEL

7. Interface Switch: A two position slide switch that properly interfaces the output of the plug-in with either the Model 1037 counter, or the Models 1034 and 1033 counter. If the plug-in is used in conjunction with either a Model 1017 or 1018 frequency counter, the interface switch should be set to the 1037 position.

8. Output Connector P1: A 50 pin connector that provides all interface with the counter unit.

Figure 3-1. Controls and Indicators (Sheet 2 of 2)

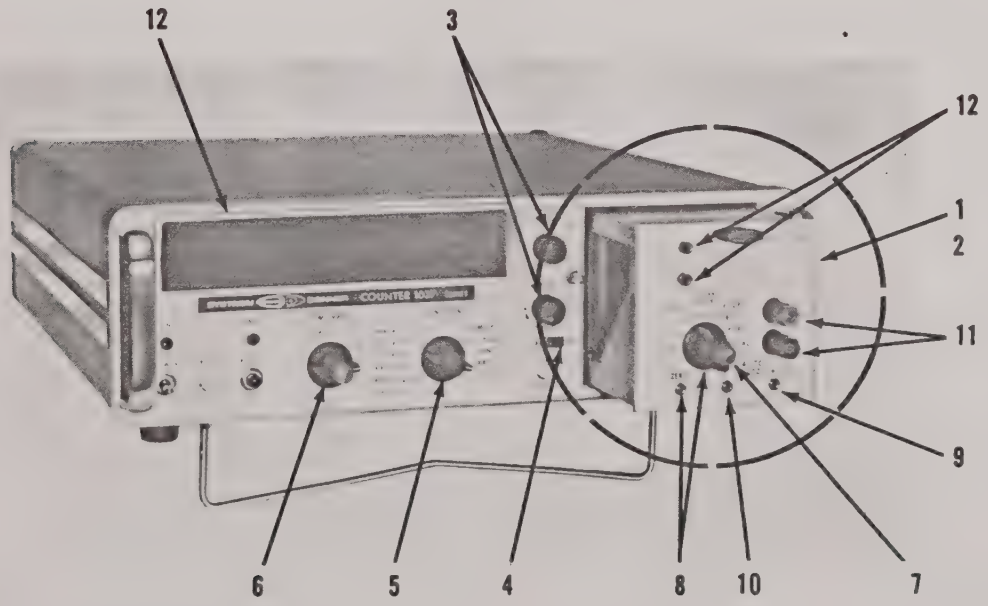


Figure 3-2. DC Voltage Measurement and Calibration Check (Sheet 1 of 2)

1. Set Model 1936 rear panel interface switch for operation with the counter selected (Model 1037 illustrated).

2. With counter POWER switch set to off (down position) install Model 1936 IDVM in counter plug-in receptacle.

3. Set counter POWER switch to on (up position).

4. Set counter RANGE switch to HET, and set LEVEL control to mid-position.

5. Set counter FUNCTION switch to RATE position.

6. Set counter TIME BASE switch to 10^{-1}, 1, or 10 seconds (depending upon measurement resolution desired). Note: Decimal point is position for 10^{-1} seconds.

7. Set plug-in FILTER switch for desired level of AC rejection.

8. Set plug-in range switch to ZERO and adjust ZERO control for a counter front panel display of zero ±2 counts.

9. Set plug-in range switch to +CAL and adjust CAL TO +8.000 control for counter front panel display of +8.000 (±0.001).

10. Set plug-in range switch to -CAL and adjust CAL TO -8.000 control for counter front panel display of -8.000 (±0.001).

11. Set plug-in range switch to 1000 volt position, and connect voltage source to plug-in binding posts. Observe counter front panel display, and set plug-in range switch to lowest range that will accomodate measurement value without causing overload.

12. Observe final voltage level on counter front panel display, and voltage polarity indicated by neon polarity indicators mounted on plug-in front panel.

Figure 3-2. DC Voltage Measurement and Calibration Check (Sheet 2 of 2)

CHAPTER 4

PRINCIPLES OF OPERATION

4-1. SYSTEM OPERATING PRINCIPLES

4-2. The Systron-Donner Model 1936 IDVM plug-in is a voltage to frequency converter capable of converting input voltages ranging from -1500 vdc to +1500 vdc into voltage proportional frequency outputs suitable for operating a Systron-Donner counter. The voltage to frequency conversion of the Model 1936 is such that a full scale voltage input (±1, ±10, ±100, or ±1000 vdc) will result in an output pulse repetition rate of 100 KHz, allowing high resolution voltage measurements to be obtained.

4-3. The Model 1936 IDVM plug-in converts applied dc voltages to voltage proportional frequencies in the following manner. (See figure 4-1.) DC voltages applied to the front panel INPUT binding posts are classified into one of four voltage ranges (1, 10, 100, or 1000 vdc) by front panel range selector switch, S1. Range selector switch, S1, routes applied DC voltages through 1 of 4 attenuation networks to obtain normalized signals ranging from zero to one microampere (full scale) regardless of the instrument operational range selected. The normalized signal, thus obtained, is applied through an inverting, high-gain error amplifier to a threshold detector circuit and a polarity detector circuit. The polarity detector circuit senses the presence of positive or negative voltage levels and illuminates either the + or - POLARITY indicator on the IDVM front panel. The polarity detector circuit also provides enabling inputs to either the positive or negative charge dispenser circuit, depending upon input signal polarity. The threshold detector circuit senses the presence of any voltage level applied to the front panel INPUT binding posts (positive or negative) that differs from 0 vdc by more than approximately two microvolts. The threshold level thus established for minimum detectable voltage levels, is selected to ensure that the output of the positive or negative charge dispenser circuits, which are applied to the integrating capacitor, will not drive the error amplifier input through the zero voltage point, causing system oscillation and incorrect front panel voltage indications. A 1 MHz clock pluse from the counter enables the threshold detector circuits to sample the applied error amplifier voltage output level once each microsecond. When a DC voltage level which exceeds the threshold level is applied to the threshold detector, an enable signal is generated by the threshold detector, and applied to the pulse generator. When the enable signal is applied to the pulse generator, a one microsecond pulse is produced at the output of the pulse generator and applied as a control pulse to both the positive and negative charged dispensers. The pulse output of the pulse generator also supplies the voltage proportional frequency output to the decade counting circuits of the counter unit.

4-4. Each control pulse applied to the charge dispensers by the pulse generator causes one of the charge dispensers to transfer a quantum of charge to the integrating capacitor, connected to the error amplifier input. The +enable and -enable outputs of the polarity detector determine which of the charge dispensers applies the quantum of charge to the integrating capacitor, and thereby, determines the polarity of the charge applied to the integrating capacitor. The charge applied to the integrating capacitor always opposes the input DC voltage, and charges the integrating capacitor toward a zero vdc (ground) level. Quanta of charge applied by the enabled charge dispenser to the integrating capacitor, charge the integrating capacitor sufficiently close to zero vdc to reduce the output of the error amplifier below the threshold level of the threshold detector, removing the enable signal from the pulse generator. When the enable signal is removed from the pulse generator, the pulse generator is allowed to reset, removing the postive and negative control pulses from the charge dispensers, and removing the voltage proportional frequency output from the counter. The system remains in this reset, or quiescent, state until sufficient charge has been drained from the integrating capacitor to allow the output of the error amplifier to once again exceed the threshold level of the threshold detector. At this time the threshold detector once again applies an enable signal to the pulse generator, which allows the charge dispensers to reduce the existing voltage level on the integrating capacitor, and applies another one microsecond pulse to the counter, increasing the count stored in the counter decade counting circuits.

4-5. Detailed circuit analysis of the functional circuits shown in figure 4-1 will be presented in the following paragraphs.

4-6. DETAILED CIRCUIT ANALYSIS

4-7. SIGNAL ATTENUATOR AND NOISE FILTER CIRCUIT

4-8. The signal attenuator and noise filter circuit is located on the switch PC board assembly. (Resistors R14 and R17 located on the amplifier assembly are also part of the attenuator circuit.) (See figure 5-4) DC voltages, to be measured by the Model 1936 IDVM are applied, through front panel INPUT connector and range selector switch, S1, to the signal attenuator and noise filter circuit. The amount of input voltage attenuation applied by the signal attenuator and noise filter circuit, is determined by the setting of switch S1. The attenuation network selected by switch S1 adjusts the current applied to the error amplifier input (summing junction) in such a manner that any full scale voltage (1, 10, 100, or 1000 vdc) applied to the front panel INPUT connector will

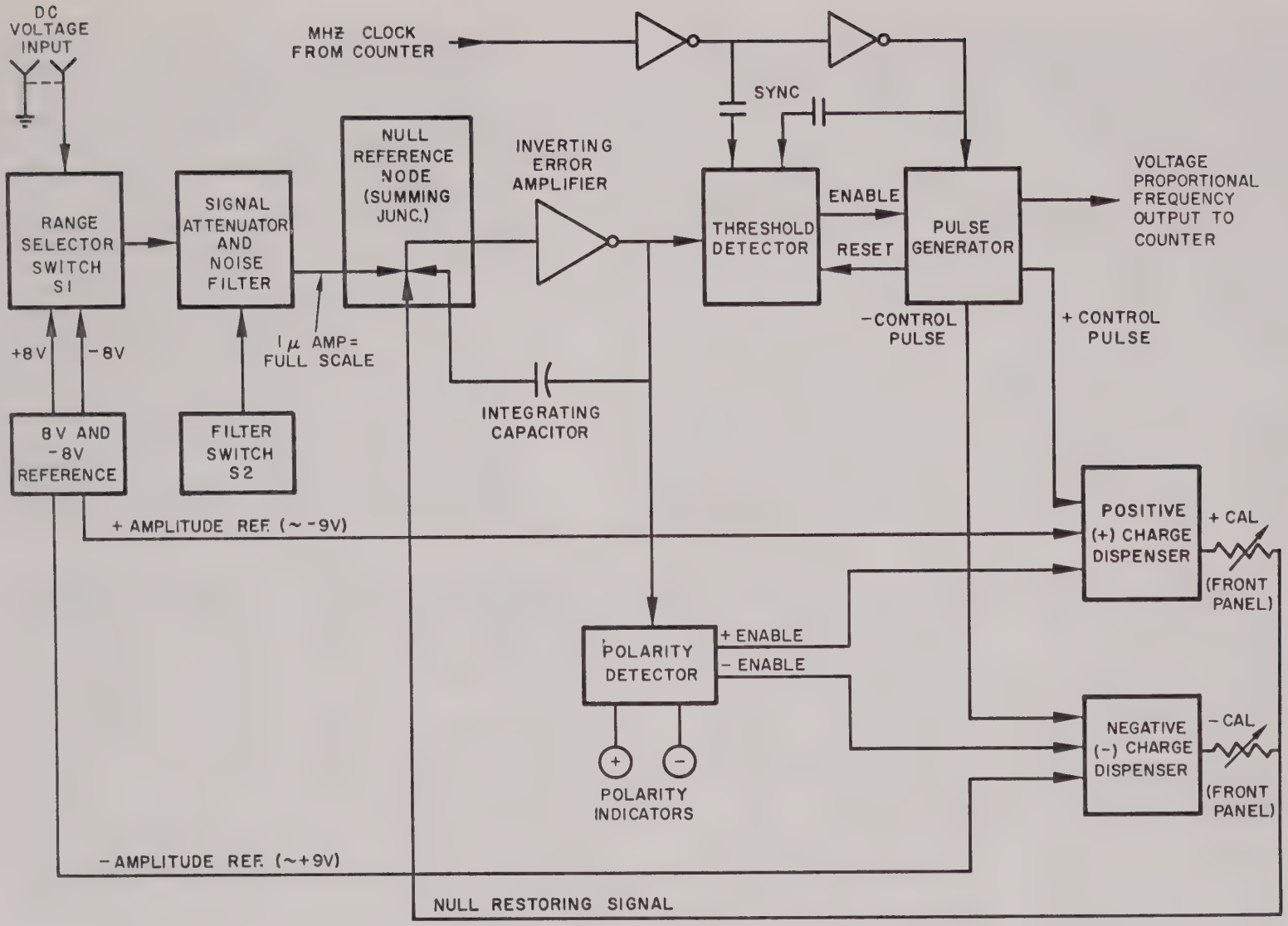


Figure 4-1. Simplified Instrument Block Diagram

result a 1μA input to the error amplifier, regardless of the operational range selected. When range selector switch, S1, is set to the one volt position the input voltage is routed through attenuating resistors, R1, R4, R5, and R14 on the amplifier assembly. When S1 is set to the 10 volt position the input signal is routed through resistors R6, R7, and R17 on the amplifier assembly. In the 100 volt position, resistor R2 is connected in series with resistors R6, R7, and R17, and shunting resistors R8 and R11 are connected between R2 and R6 providing additional signal attenuation. When switch S1 is set to the 1000 volt position, resistor R3 is connected in series with resistors R2, R6, R7, and R17, and shunting resistors R9 and R10 are connected between R2 and R6 providing maximum input signal attenuation. In this manner input voltages are adjusted to produce normalized currents at the input (summing junction) of the error amplifier.

4-9. When an input signal is observed to have a large noise content, FILTER switch, S2, can be used to provide 30db or 60db of 60 Hz AC signal rejection. FILTER switch, S2, connects either filter capacitors C1 and C3, or C1, C2, C3 and C4 into the input circuit. Capacitors C1 and C3, respectively, provide 30db of noise rejection for the 1 volt input range and the 10 to 1000 volt input ranges. Capacitors C1, C2, C3 and C4 in combination provide 60db of noise rejection for both the 1 volt input range and the 10 to 1000 volt input ranges. The AC rejection levels of 30db and 60db selected by front panel FILTER switch, S2, apply to 60 Hz noise sources. AC rejection of the noise filter circuit increases 6db per octave above 60 Hz in the 30db position and 12db per octave in the 60db position.

4-10. ERROR AMPLIFIER CIRCUIT

4-11. The error amplifier circuit (figure 5-5) is located on the operational amplifier assembly (figure 5-5), and consists of a chopper stabilized DC amplifier section and a two stage differential AC amplifier section with a high-gain inverter output. When front panel range selector switch, S1, is set to the 1 volt position, normalized currents are applied to the error amplifier through resistor R14 located on the operational amplifier assembly, charging integrating capacitor, C3. Input signal components ranging in frequency from DC to approximately 0.5 Hz are coupled through low pass filter R29-C8, and isolation resistor R30, to the emitter of transistor Q9. Input signal components above approximately 0.5 Hz are capacitively coupled through C4 to the base of transistor Q3. The inputs to Q3 and Q9 are shielded (figure 5-5) to prevent leakage of DC current into the summing junction. The low frequency (less than approximately 0.5 Hz) signal components passed by low pass filter R29-C8 are chopped by transistor switch, Q9, at a rate established by free-running multivibrator Q1-Q2. The resulting chopped signal is coupled through capacitor C9, to the base of transistor Q10 of differential amplifier Q10-Q11. The chopped signal applied to the base of Q10 is effectively isolated from the amplifier input circuit by resistor R30 and capacitor C8 which act as a spike rejection filter.

4-12. The chopped signal applied to the base of Q10 is amplified by differential amplifier Q10-Q11, and applied to the base of inverting amplifier Q12. The output of inverting amplifier Q12 is applied to the base of inverting amplifier Q13, which restores original signal polarity. Capacitor C14 stabilizes inverting amplifier Q13 by providing degenerative local feedback from the collector to the base of Q13. The chopper amplifier is further stabilized by providing feedback of high frequency signal components from the collector of Q13 through RC circuit R42-C12 to the base of Q11. The DC operating points of Q12 and Q13 are determined by the network R48-R39-R41.

4-13. The amplified carrier output of Q13 is coupled through capacitor C13 to the collector of demodulation switch Q14. Q14 alternately connects to ground, and isolates from ground the junction between C13 and R37. Because Q14 is operated 180 degrees out of phase with chopping transistor switch, Q9, the junction between C13 and R37 is grounded when the output of Q13 is most positive, and is isolated from ground when the output of Q13 is most negative. In this manner the demodulated output of the chopper amplifier is inverted before being applied through low pass filter R37-C6 to the base of transistor Q4. Low pass filter assembly R37-C6 is inserted between the base of Q4 and the collector of demodulated switch Q14, to prevent the passage of spike voltages from the chopper amplifier output to the base of Q4.

4-14. Transistors Q3, Q4, Q5 and Q6 form a two stage cascade differential amplifier which exhibits unusually low DC drift. The inverted output of the chopper amplifier section, and the high frequency (above 0.5 Hz) AC component of the input voltage are applied, respectively, to the bases of transistors Q4 and Q3. The signals applied to the bases of Q4 and Q3 are amplified by transistors Q3, Q4, Q5, and Q6, and are applied to the base of transistor Q8 as an amplified, non-inverted representation of the applied input voltage. Transistors Q7 and Q8 form a high-gain inverting amplifier which provides the error amplifier output voltage to the threshold detector circuit. RC circuits R20-C5 and R23-C7 prevent oscillation of the error amplifier by causing amplifier output to roll off gradually with increasing frequency.

4-15. When an active voltage level is sensed by the threshold detection circuit, the restoration (nullifying) current pulse applied by one of the charge dispenser circuits is coupled through resistor R15 (positive charge dispenser) or resistor R16 (negative charge dispenser), to the summing junction, thereby reducing the voltage on integrating capacitor C3. When C3 has been sufficiently discharged by the output of A the charge dispenser, the output of the error amplifier falls below the threshold level of the threshold detector circuit, and the charge dispenser circuits are disabled, removing no further charge from integrating capacitor, C3.

4-16. When front panel range selector switch, S1, is set to the 10, 100 or 1000 volt position, input voltages are routed into the error amplifier through resistor R17, and are processed in a manner similar to that just discussed.

4-17. THRESHOLD DETECTOR CIRCUIT

4-18. The threshold detector circuit (figure 5-6) located on the threshold detector and polarity assembly, consist of low pass filter, R3-C2 - R4-C3; pedestal gating circuits, C4-R6 and C5-R5; bistable threshold circuit, Q1-Q2; and buffer amplifier, Q3. Voltage outputs from the error amplifier are applied through low pass filter, R3-C2 - R4-C3, to resistors R5 and R6 of pedestal gates, R5-C5 and R6-C4. If the inverted voltage output of the error amplifier is above approximately +2 vdc, a pedestal voltage level is applied at the anode of diode CR2, allowing the free-running, 1 MHz, B sync pulse applied to capacitor C4 to be coupled through CR2 to the base of transistor Q2, driving Q2 to conduction. In a similar manner, if the inverted output of the error amplifier is more negative than approximately -2 vdc, the free-running 1 MHz, A sync pulse applied to capacitor C5 is coupled through diode CR1 to the base of transistor Q1, driving Q1 to conduction. (Refer to figure 4-2 for circuit timing interrelations.) Tunnel diodes CR3 and CR4 provide low impedance paths to ground, holding transistors Q1 and Q2 in the off state until the current level applied to either CR3 or CR4 exceeds the peak current (1 Ma.) of the diode. When this current level is reached the diode switches to the 'high voltage' state rapidly allowing either Q1 or Q2 to be driven to conduction. Using tunnel diodes CR3 and CR4 in this manner establishes the circuit threshold, and prevents the A sync and B sync pulses from appearing at the threshold detector output.

4-19. Transistors Q1 and Q2 form a bistable circuit in which conduction of one transistor causes conduction of both transistors. Because bistable circuit Q1-Q2 operates in this manner, application of a positive or negative voltage output from the error amplifier, which exceeds the threshold level (±2 vdc) of the threshold circuit, will cause conduction of both Q1 and Q2 producing an active (approx. 0 v) output at the collector of transistor Q2. This active output indicates the presence of either a positive or negative voltage output from the error amplifier, which exceeds the threshold level of the threshold detector. An active (low) signal occuring at the collector of transistor Q2 is applied, through RC circuit C8-C14, to the base of inverting buffer amplifier, Q3. The output of Q3 provides a control gating pulse to the pulse generator circuits, which enables or disables the voltage-proportional-frequency output of the pulse generator to the counter unit and the charge dispenser circuits.

4-20. Two microseconds after the occurrence of a control gating pulse the threshold detector bistable circuit is reset by the positive going excursion of the reset pulse from the pulse generator circuit. This positive going reset pulse is coupled through R35, C9 and CR5 to the base of transistor Q1, driving Q1 to cutoff, driving Q2 to cutoff and thereby resetting the threshold bistable circuit. Resetting the threshold bistable circuit in this manner, allows the error amplifier output voltage level to be sampled anew every 2 microseconds by the A sync and B sync pulses applied by the pulse generator to the threshold detector. The negative going trailing edge of the reset pulse, is used to trigger inverting transistor switch Q8, thereby allowing the polarity detector circuit to sample the polarity of the error amplifier output voltage. The discussion of the functioning of the polarity detector circuitry is presented in the following paragraphs.

4-21. POLARITY DETECTOR CIRCUIT

4-22. The error amplifier output applied to the threshold detector circuits is also applied to the polarity detector circuit. The polarity detector circuit (figure 5-7) is mounted on the threshold and detector polarity assembly, and consists of low pass filter, R2-C1; inverting, saturating amplifiers Q4, Q5, and Q9; inverting transistor switch, Q8; pedestal gates, C12-R25 and C13-R23; and bistable indicator driver circuit, Q6-Q7. Positive or negative voltage level outputs of the error amplifier are applied through low pass filter, R2-C1, to the bases of saturating amplifiers Q4 and Q5. If the applied voltage level is positive (indicating a relatively negative input voltage) transistor Q5 will be driven to saturation and transistor Q4 will be driven to cutoff. Driving transistor Q5 to conduction causes transistor Q9 to saturate, producing a relatively positive voltage level at the collector of Q9, while driving transistor switch Q4 to cutoff produces a relatively negative voltage level at the collector of Q4. The voltage levels present at the collectors of Q4 and Q9 provide pedestals, allowing the (negative going) reset pulse from the pulse generator circuit, acting through inverting transistor switch Q8 and capacitors C12 and C13, to set bistable indicator driver circuit Q6-Q7 to one of its two states. When a relatively positive voltage level is present on the collector of Q9 and a relatively negative voltage level is present on the collector of Q4, a positive voltage pedestal is established at the anode of diode CR7, which allows the positive going voltage spike from transistor Q8, acting through capacitor C12, to drive the base of transistor Q6 to conduction, thereby driving transistor Q7 to cutoff, and producing a front panel -POLARITY indication. The relatively negative voltage pedestal established by transistor Q4 at the anode of diode CR6 prevents the positive going voltage spike output of transistor Q8, which is applied to capacitor C13, from reaching the base of transistor Q7, thereby ensuring that transistors Q6 and Q7 are not driven to the on condition simultaneously. A negative voltage (indicating a relatively positive input voltage) applied to the bases of Q4 and Q5 would be processed in a similar manner, except that Q4 would conduct, producing a relatively positive voltage level at the anode of CR6, allowing the voltage spike applied through C13 to drive Q7 to conduction, thereby producing a +POLARITY front panel indication.

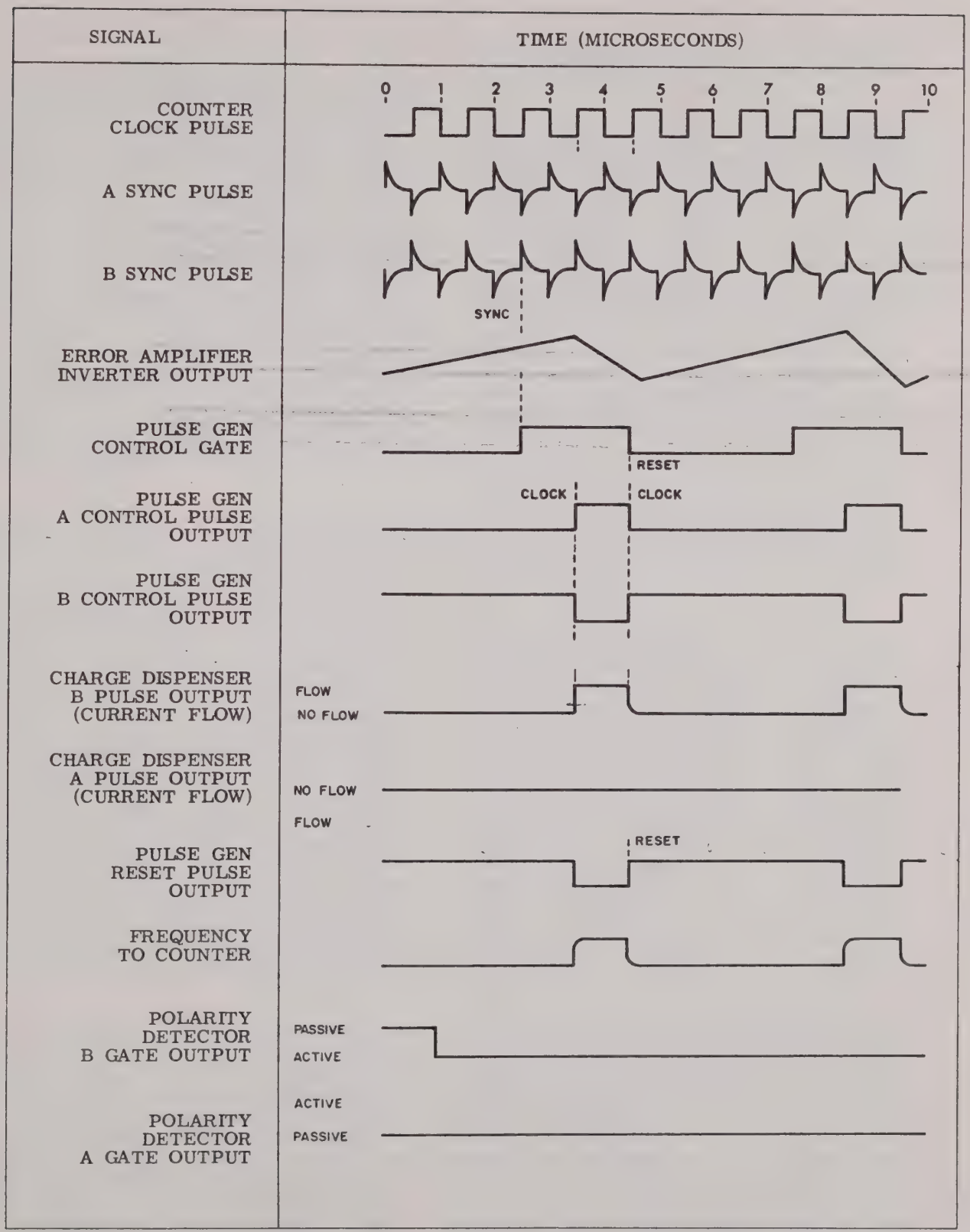


Figure 4-2. Timing Diagram for Negative Voltage Input

4-23. PULSE GENERATOR CIRCUIT

4-24. The pulse generator circuit (figure 5-8) is located on the pulse generator assembly, and consists of inverting drivers, Q1 and Q2; pedestal gates, C5-R21 and C6-R20; two stage pulse generator bistable circuit, Q3-Q4-Q5-Q6; and inverting buffers, Q7 and Q8. A 1 megacycle, free running clock pulse from the counter is applied to the pulse generator assembly at pin R of connector J5. The applied clock pulse is coupled through RC circuit C4-R17 to the base of inverting driver Q1. The inverted output of Q1 is coupled through RC circuit C1-R10, to the base of inverting driver, Q2, and is applied through differentiating capacitor, C7, to the threshold detector circuit, as the A sync pulse. RC circuits C4-R17 and C1-R10 maintain the integrity of the 1 megacycle clock pulse train processed by Q1 and Q2, ensuring that the pulse train outputs of Q1 and Q2 will be free from distortion. The inverted output of Q2 is applied to pedestal gates, C5-R21 and C6-R20, and is coupled through differentiating capacitor, C8, to the threshold detector circuits as the B sync pulse.

4-25. Pedestal gate, C6-R20, allows the pulse generator bistable circuit to be set (Q4 and Q5 'ON'), while pedestal gate, C5-R21 allows the bistable circuits to be reset (Q4 and Q5 'OFF'). To set the pulse generator bistable circuit, a relatively positive control gate input is required from the threshold detector circuit. The relative positive voltage level established by this input at the anode of diode CR7, allows the next positive going excursion of the free running, 1 megacycle output of Q2, acting through C6, to drive transistor Q5 to conduction. When Q5 is driven to conduction, the output of Q5 drives Q6 to cutoff, causing the base of transistor Q4 to be driven relatively negative. The negative going voltage thus applied to the base of transistor Q4, drives Q4 to conduction, turning Q3 off, and increasing the positive voltage level applied to the base of transistor Q5. In this state (Q4-Q5 conducting, Q3-Q6 cutoff), a positive going A control pulse is applied to the negative charge dispenser circuit, a negative going B control pulse is applied to the positive charge dispenser circuit, a positive going reset pulse is applied through inverter driver, Q7, to the polarity detector circuit, and a negative going count pulse is applied through inverter driver, Q8, to the counter.

4-26. With the pulse generator bistable circuit in this set condition, the relatively positive voltage level present at the emitter of Q3 creates a relatively positive voltage pedestal at the anode of diode CR6, which allows the next positive going pulse from Q2 to be oupled through C5 and CR6 to the base of Q4, driving Q4 to cutoff. When Q4 is driven to cutoff, Q3 is driven to conduction, driving the base of Q5 relatively negative, and thereby driving Q5 to cutoff. When Q5 is driven to cutoff, Q6 is driven to conduction driving the base of transistor Q4 relatively more positive, thereby ensuring transistor Q4 cutoff. In this reset state, the A control pulse and B control pulse are removed from the positive and negative charge dispensers, a reset pulse is applied to the threshold detector circuit, and the count pulse output is removed from the counter.

4-27. In a similar manner, whenever a relatively positive control gate pulse is applied to the pulse generator circuit, following reset of the pulse generator bistable circuit, the set and reset cycles, just discussed, will occur.

4-28. POSITIVE AND NEGATIVE CHARGE DISPENSER CIRCUITS

4-29. Because the operation of the positive and negative charge dispenser circuits are functionally identical, only the positive charge dispenser circuit will be covered in this discussion. The positive charge dispenser circuit (figure 5-8) is mounted on the charge dispenser assembly, and consists of transistor switch, Q4; complementary symmetrical amplifier, Q2-Q3; transistor switch, Q1; and reference source CR1-C1-R1-R2-R3-R4.

4-30. In the presence of a relatively positive level from the polarity detector circuit, inhibit transistor switch, Q4, is driven to cutoff removing the inhibiting, negative voltage level from the base of Q2, thereby making transistor Q2 permissive to the A control pulses from the pulse generator circuit. Q3 is not gated as it cannot produce an output without Q2.

4-31. Positive going A control pulses applied to the charge dispenser circuit drive Q3 to cutoff and Q2 to conduction, providing an amplified, negative going signal at the collector of Q2. This negative going signal is applied to the base of transistor switch Q1, driving Q1 to conduction, and thereby permitting charge to be transferred to integrating capacitor, C3, located on the operational amplifier assembly, from constant voltage supply CR1-C1-R1-R2-R3-R4 connected to the collector of Q1. Charge will be transferred from the constant voltage source to the integrating capacitor, as long as transistor Q1 is held in conduction by the relatively negative output of amplifier Q2-Q3. Q2-Q3, in turn, maintains its relative negative output as long as the A control pulse from the pulse generator circuit is present. The duration of the A control pulse is established at 1 micorsecond by the 1 MHz free running clock pulse frequency.

4-32. At the termination of the A control pulse from the pulse generator, Q2 is driven to cutoff and Q3 to conduction, turning transistor switch, Q1, off, and terminating the transfer of charge from the constant voltage source to the integrating capacitor. The quantity of charge transferred to the integrating capacitor is very precisely controlled by regulating the period of charge transfer in the manner just described, and by regulating the rate of charge transfer. The rate of charge transfer is regulated by closely controlling the constant voltage source, and by closely controlling the charge dispenser circuit output series resistance. The constant voltage level is established by R1 and zener diode CR1. Output series resistance is closely controlled by factory selecting resistors

R5, R6, R7, and R8. Resistors R5 and R6 are silicon resistors, having a temperature coefficient of +0.7%/°C and are factory selected to compensate for the temperature drift introduced by various components in the instrument. In this manner the quantity of charge dispensed to the integrating capacitor during each A control pulse is precisely regulated.

4-33. POWER SUPPLIES

4-34. All primary power is supplied to the Model 1936 IDVM by the counter unit. The source voltages provided by the counter are +225 vdc, +30 vdc, and -30 vdc. From these three primary voltage sources, voltage regulating circuitry within the Model 1936, generates all other DC voltages required by the circuits of the Model 1936. Voltage regulator circuits R7-CR4 and R8-CR3, mounted on the instrument main chassis, (figure 5-3) provide the -15 vdc and +15 vdc supply voltages, respectively, used in the instrument. Voltage regulator circuits R5-CR1 and R6-CR2, also mounted on the instrument main chassis, respectively, provide the -12 vdc and +12 vdc supply voltages. Voltage regulator circuits R53-CR12 and R52-CR11, mounted on the operational amplifier assembly, respectively, provide the -10 vdc and +10 vdc supply voltages. The precision of +8 vdc and -8 vdc supply voltages used to dynamically calibrate the Model 1936, are obtained, respectively, from the precision voltage divider networks of constant voltage supplies CR6-C8-R30-R27-R28-R29 and CR1-C1-R1-R3-R2-R4 on the charge dispenser assembly.

CHAPTER 5

MAINTENANCE

5-1. TEST EQUIPMENT REQUIRED

5-2. Test equipment required to check, calibrate, and troubleshoot the Systron-Donner Model 1936 IDVM are listed in Table 5-1. Critical performance capabilities of each item of test equipment are also presented in Table 5-1.

5-3. PERFORMANCE CHECK

5-4. The performance check consists of a test of the Model 1936 against its performance specifications. The performance check is useful as a quality control receiving inspection check, a periodic certification check, and a post troubleshooting certification check. The procedures contained in this performance check do not directly measure all of the performance specifications listed in Table 1-1, however, successful completion of these procedures indicates, implicitly, conformance to all performance specifications.

5-5. Before beginning the performance check procedures, inspect the instrument to be tested for physical damage or mechanical difficulties. After inspection connect the Model 1936 as shown in figure 5-1, then apply power to the instrument under test and allow fifteen minutes for instrument warmup. After warmup period, proceed to the performance check procedures listed below.

NOTE

Counter control settings listed in this section apply to the Systron-Donner Model 1037. If other Systron-Donner counters are to be used, refer to the counter instruction manual for equivalent control settings.

a. Set counter front panel controls as follows: TIME BASE switch to 1 (seconds), RANGE switch to HET, and FUNCTION switch to RATE.

b. Using multimeter, measure the following voltages on Charge Dispenser Assembly Connector.

Pin J - -15 (±0.8) vdc

Pin S - +15 (±0.8) vdc

Pin A - -12 (±0.6) vdc

Pin F - +12 (±0.6) vdc

5-7. SELF CALIBRATE

a. Install Model 1936 in electronic counter.

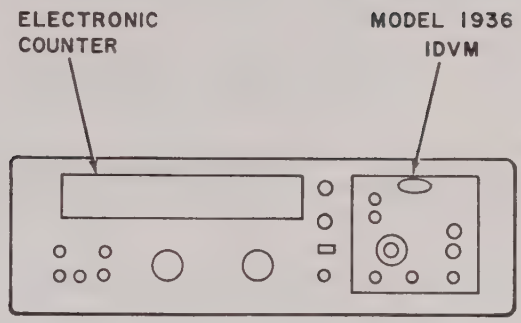


Figure 5-1. Test Setup, Voltage Supply Check

b. Set counter front panel controls as follows:

TIME BASE - 1 (second)

RANGE - HET

FUNCTION - RATE

c. Adjust Model 1936 front panel ZERO adjustment to obtain a 0.000 (±5 counts) counter display.

d. Set DC voltage standard output to +8.000 vdc, and adjust Model 1936 front panel +CAL adjustment for a counter display of 80.000 (±5 counts).

e. Set DC voltage standard for a -8.000 vdc output, and adjust Model 1936 -CAL adjustment to obtain a -8.000 (±5 counts) counter display.

5-8. DYNAMIC RESPONSE AND LINEARITY CHECK

a. Install the Model 1936 in the counter, set range selector switch to 10, and connect DC voltage standard to Model 1936 front panel input connectors.

b. Set DC voltage standard for +10.000 vdc output.

c. Set counter front panel controls as follows:

TIME BASE - 10^{-1} (seconds)

RANGE - HET

FUNCTION - RATE

d. Observe 10.000 (±0.002) counter display, and observe +POLARITY indication on Model 1936 front panel.

Table 5-1. Required Test Equipment

EQUIPMENT TYPE	CRITICAL SPECIFICATION	RECOMMENDED TEST EQUIPMENT
Oscilloscope	Bandwidth: 50 MHz Vertical Sensitivity: 100 mv/cm	Tektronix Model 581 with Model 82 preamplifier (with X10 probes)
Secondary DC Voltage Standard	Accuracy: ±0.005% Range: +1111 vdc to -1111 vdc	Fluke, Model 332A
Multimeter	Measurement Modes: vdc, ohms, current Voltage Range: +30 vdc to -30 vdc Input Resistance: Greater than 10 MEGO	Hexem Inc., Model 110
Electronic Counter	Not applicable	Systron-Donner Model 1037 (S-D Models 1017, 1018, 1033, 1034, or 1038 only may be substituted)

e. Set DC voltage standard for -10.000 vdc output.

f. Observe 10.000 (±0.002) control display, and observe -POLARITY indication on Model 1936 front panel.

g. Set DC voltage standard as directed by Table 5-2, and observe the corresponding counter front panel displays.

Table 5-2. Dynamic Input Accuracies

DC Standard Output	Counter Display
GROUND	0.000 (±0.002)
1.000	1.000 (±0.002)
5.000	5.000 (±0.002)
15.000	15.000 (±0.003)
20.000	20.000 (±0.015)
30.000	30.000 (±0.020)

5-9. HIGH VOLTAGE CHECK

a. Install Model 1936 in counter, and connect the DC voltage standard to the Model 1936 front panel input connectors.

b. Set counter front panel controls as follows:

TIME BASE - 10^{-1} (second)

RANGE - HET

FUNCTION - RATE

c. Set Model 1936 range selector switch to 1000.

d. Apply power to the high voltage power supply; allow 15 minutes warmup period, then adjust DC voltage standard for +1100 vdc otuput.

e. Observe 1100.0 (±0.2) counter display, and observe +POLARITY indication on Model 1936 front panel.

5-10. CALIBRATION PROCEDURES

5-11. Before performing the calibration procedures, verify that an out of specification condition exists using the performance check procedures contained in this section. If a grossly out of specification condition exists, troubleshoot the instrument and replace faulty circuit components before performing calibration adjustments. Table 5-1 provides a recommended list of test equipment required to perform the calibration procedures. Allow 30 minutes warmup. The top covers of the counter and the 1936 should be removed only momentarily while making adjustments so that proper thermal equilibrium is maintained.

5-12. INTERNAL VOLTAGE REFERENCE ADJUSTMENT

a. Connect Model 1936 as shown in figure 5-2.

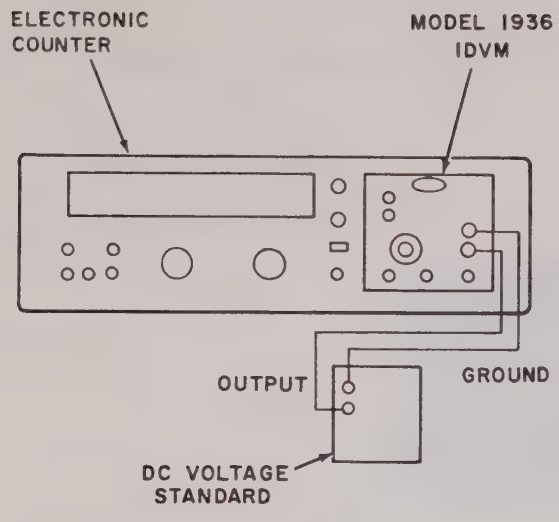


Figure 5-2. Test Setup, Internal Voltage Reference Adjustment

b. Set counter TIME BASE to 1.

c. Set Model 1936 +CAL and -CAL front panel adjustments to mid position.

d. Set DC voltage standard for +8.000 vdc output.

e. Set Model 1936 range selector switch to 10 and +CAL positions alternately, adjusting R28 on Charge Dispenser Assembly, to obtain a similar counter front panel display (±5 counts) in both switch positions.

f. Set DC voltage standard for -8.000 vdc output.

g. Set Model 1936 range selector switch to 10 and +CAL positions alternately, adjusting R2 on Charge Dispenser Assembly, to obtain a similar counter front panel display (±5 counts) in both switch positions.

5-13. OPERATIONAL CALIBRATION ADJUSTMENT

a. Connect Model 1936 as shown in figure 5-2.

b. Set counter front panel controls as follows:

TIME BASE - 1 (second)

RANGE - HET

FUNCTION - RATE

c. Set DC voltage standard for a zero vdc output.

d. Set Model 1936 range selector switch to 1 volt position.

e. Adjust Model 1936 front panel ZERO adjustment to obtain a 0.000 (±5 counts) counter display.

f. Set DC voltage standard output to +8.000 vdc, and adjust Model 1936 front panel +CAL adjustment for a counter display of 80.000 (±5 counts).

g. Set DC voltage standard for a -8.000 vdc output, and adjust Model 1936 -CAL adjustment to obtain a -8.000 (±5 counts) counter display.

h. Set DC voltage standard for a +1.000 vdc output, and set Model 1936 range selector switch to 1 volt range. Adjust potentiometer R1 on switch PC board assembly (figure 5-4) to obtain a counter front panel display of +10.0000 (±5 counts).

i. Set DC voltage standard for an output of +100.00 vdc, set 1936 to 100 and adjust potentiometer R8 on switch PC board assembly to obtain a counter front panel display of +1000.00 (±5 counts).

j. Set the DC voltage standard for an output of +1000.0 vdc, set 1936 to 1000. Adjust potentiometer R9 on switch PC board assembly to obtain a counter display of 10000.0 (±5 counts).

5-14. TROUBLESHOOTING

5-15. Table 5-3 provides waveforms and DC voltages which can be used to effectively isolate instrument malfunctions to a printed circuit card or major chassis mounted component. The schematics and interconnecting diagrams provided at the end of this chapter are also of use in troubleshooting the instrument. The waveforms and voltages listed in Table 5-3 were obtained with the Model 1936 installed in a S-D Model 1937 counter, and with the Model 1936 range selector switch set to +CAL position.

NOTE

Should repair of the operational amplifier assembly, or the switch PC board assembly be required, moisture proof varnish must be applied to the area of repair.

Table 5-3. Troubleshooting Waveforms and DC Voltages (Sheet 1 of 3)

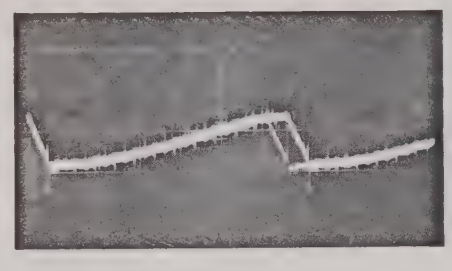
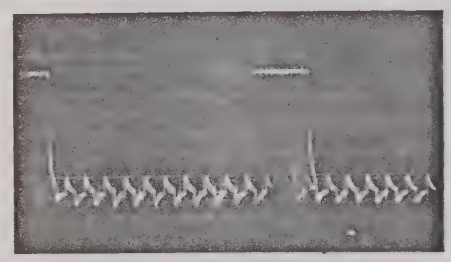
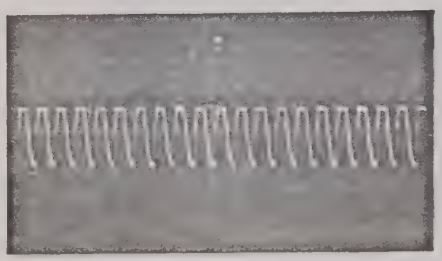
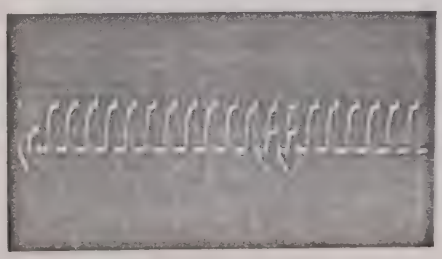
ASSEMBLY AND TEST POINT	OUTPUT REQUIRED	MEASUREMENT EQUIPMENT REQUIRED
Operational Amplifier Assembly		
Pin R		Oscilloscope 200 mv/cm VERT 2 μs/cm HORIZ
Pin P	+10 (±0.1) vdc	Multimeter
Pin M	-10 (±0.5) vdc	Multimeter
Threshold Detector and Polarity Assembly		
Pin W		Oscilloscope 5 v/cm VERT 2 μs/cm HORIZ
Pin H	+5 to +8 v	Multimeter
Pin K	-12 to -15 v	Multimeter
Pin A	+55 to +100 v	Multimeter
Pin B	-0 to +2 v	Multimeter
Pulse Generator Assembly		
Pin R		Oscilloscope 5 v/cm VERT 2 μs/cm HORIZ
Pin J		Oscilloscope 1 v/cm VERT 2 μs/cm HORIZ

Table 5-3. Troubleshooting Waveforms and DC Voltages (Sheet 2 of 3)

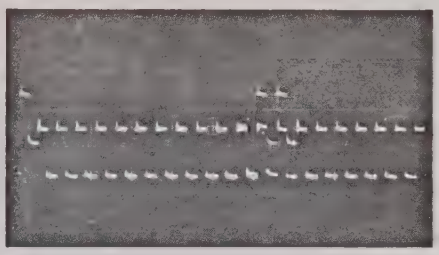
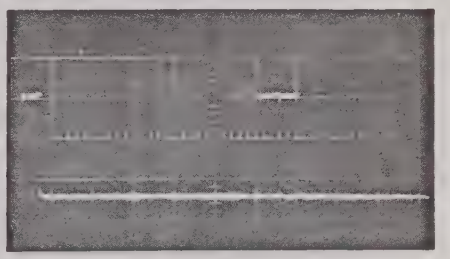
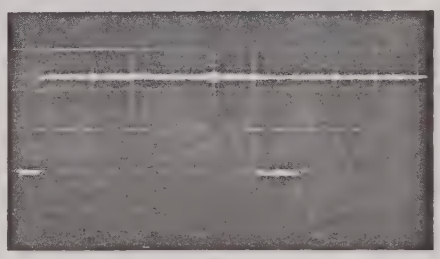
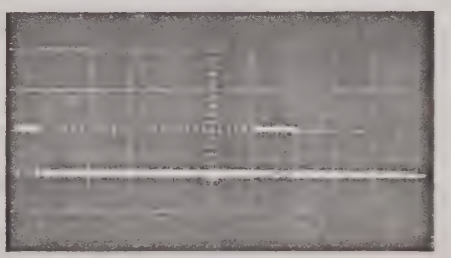
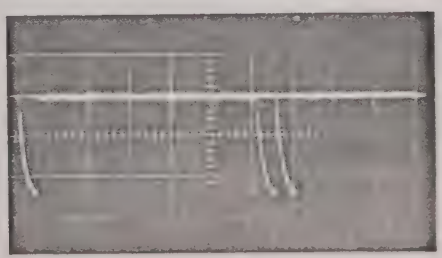
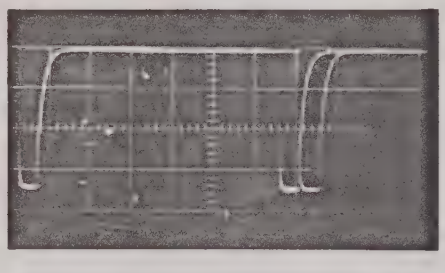
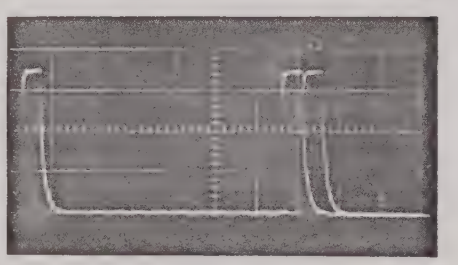
ASSEMBLY AND TEST POINT	OUTPUT REQUIRED	MEASUREMENT EQUIPMENT REQUIRED
Pulse Generator Assembly (cont)		
Pin E		Oscilloscope 1 v/cm VERT 2 μs/cm HORIZ
Pin F		Oscilloscope 5 v/cm VERT 2 μs/cm HORIZ
Pin T		Oscilloscope 5 v/cm VERT 2 μs/cm HORIZ
Pin X		Oscilloscope 5 v/cm VERT 2 μs/cm HORIZ
Pin H		Oscilloscope 5 v/cm VERT 2 μs/cm HORIZ

Table 5-3. Troubleshooting Waveforms and DC Voltages (Sheet 3 of 3)

ASSEMBLY AND TEST POINT	OUTPUT REQUIRED	MEASUREMENT EQUIPMENT REQUIRED
Charge Dispenser Assembly		
Pin M	-8.000 (±0.001) vdc	Multimeter
Pin N	+8.000 (±0.001) vdc	Multimeter
Pin C		Oscilloscope 2 v/cm VERT 2 μs/cm HORIZ
Pin X		Oscilloscope 2 v/cm VERT 2 μs/cm HORIZ
Pin U	-12 (±0.6) vdc	Multimeter
Pin Z	+12 (±0.6) vdc	Multimeter

Oscilloscope

Tektronix 581 Main unit

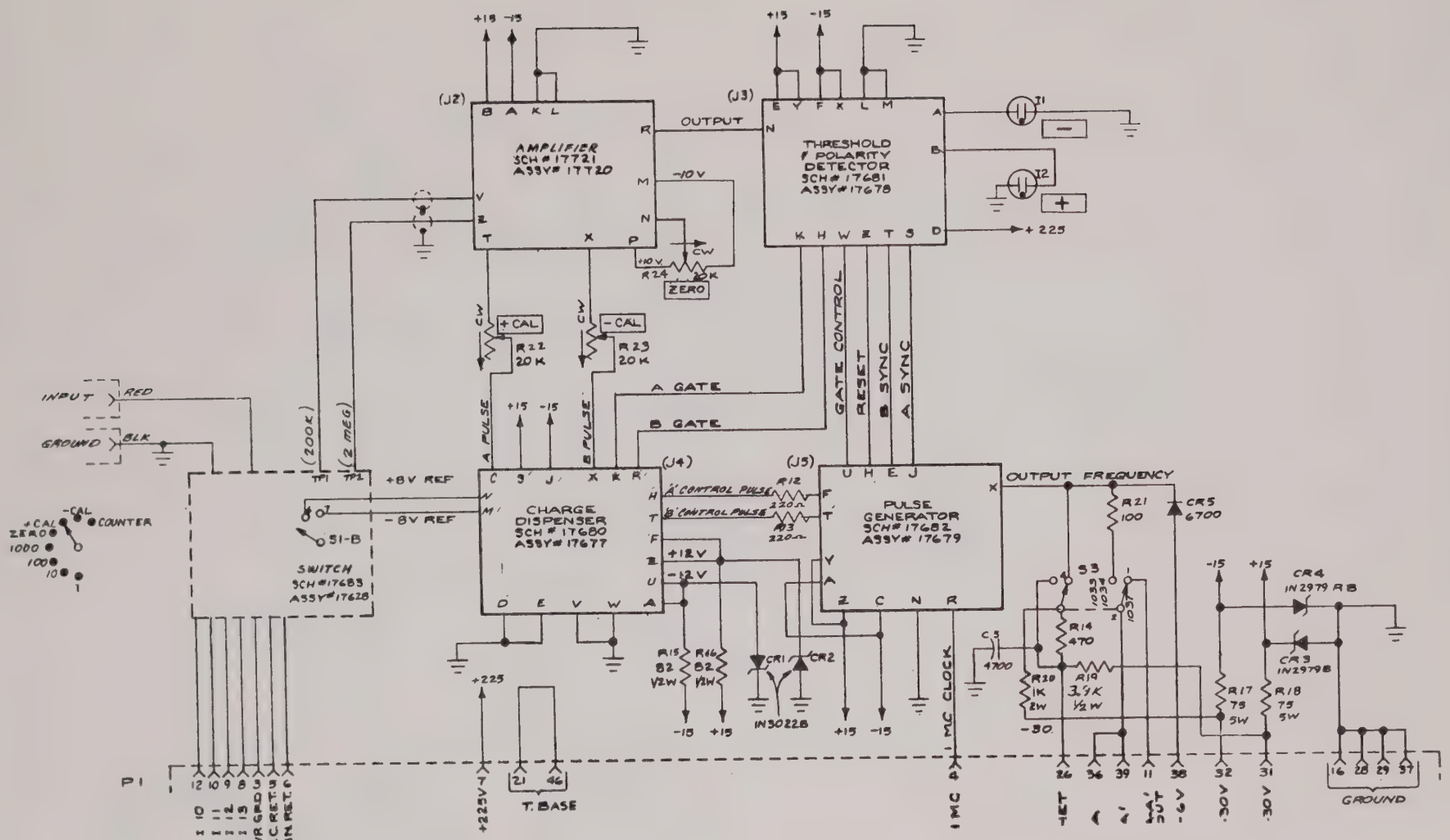
Tektronix 82 Plug-in unit with x10 probe

Sweep synchronized to leading edge (+) of output waveform on J5, pin X (waveform 8).

Multimeter

Hexem Inc. Model 110B

10 Meg minimum input resistance on 10 v range

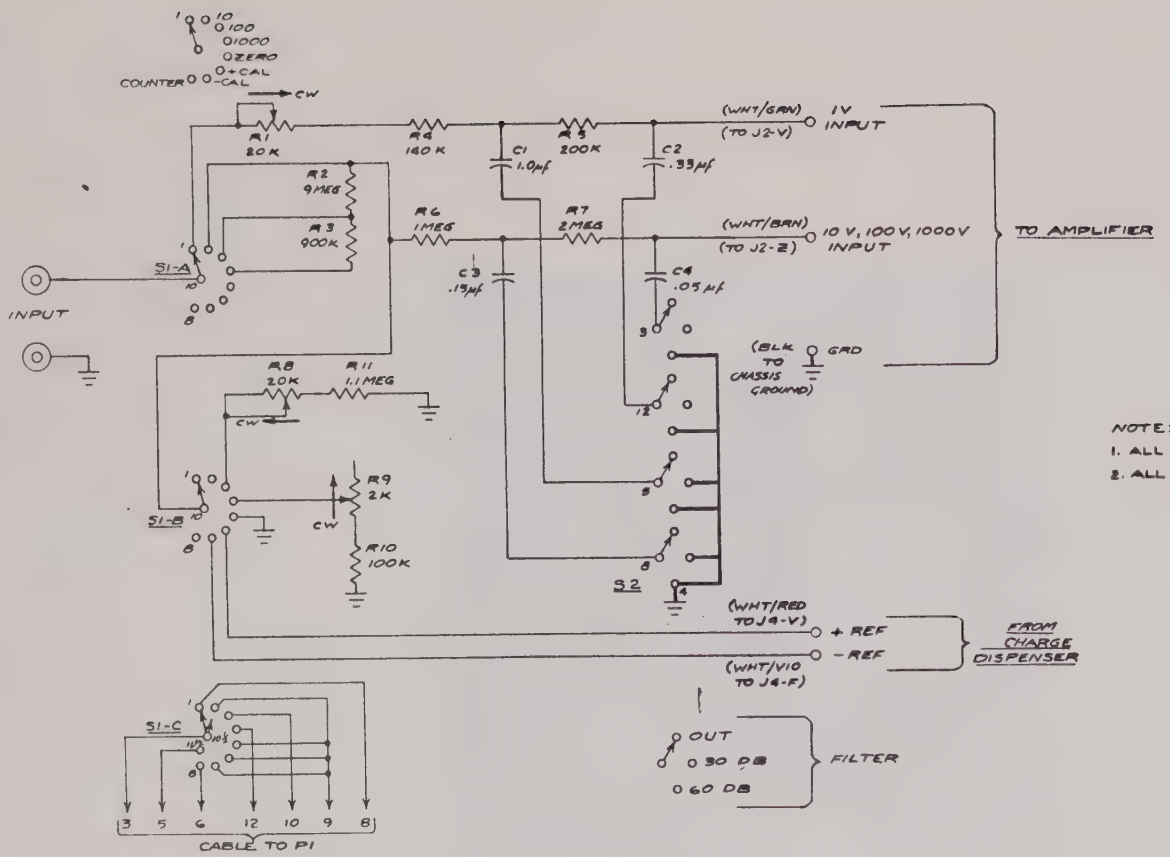


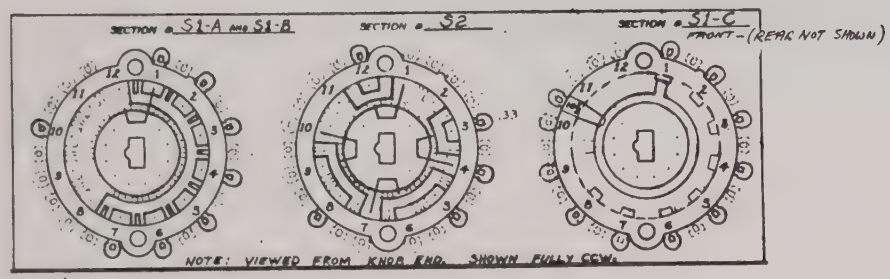
NOTE:

1. 'A' IS ASSOCIATED WITH THE MEASUREMENT OF POSITIVE VOLTAGE AND "B" WITH NEGATIVE.

SCHEMATIC
BLOCK DIAGRAM
MODEL 1936

17802





NOTE:
1. ALL RESISTORS ± 1%
2. ALL CAPACITORS ± 20%, 200V.

SCHEMATIC
SWITCH
P C BOARD

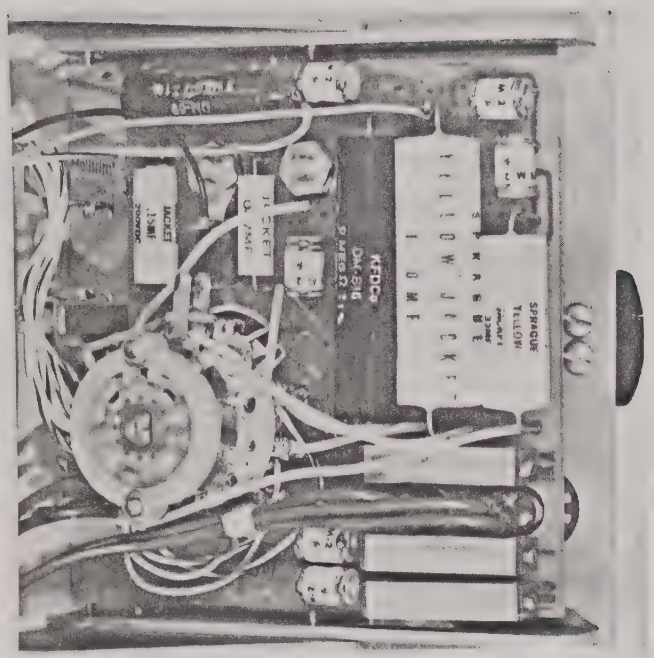
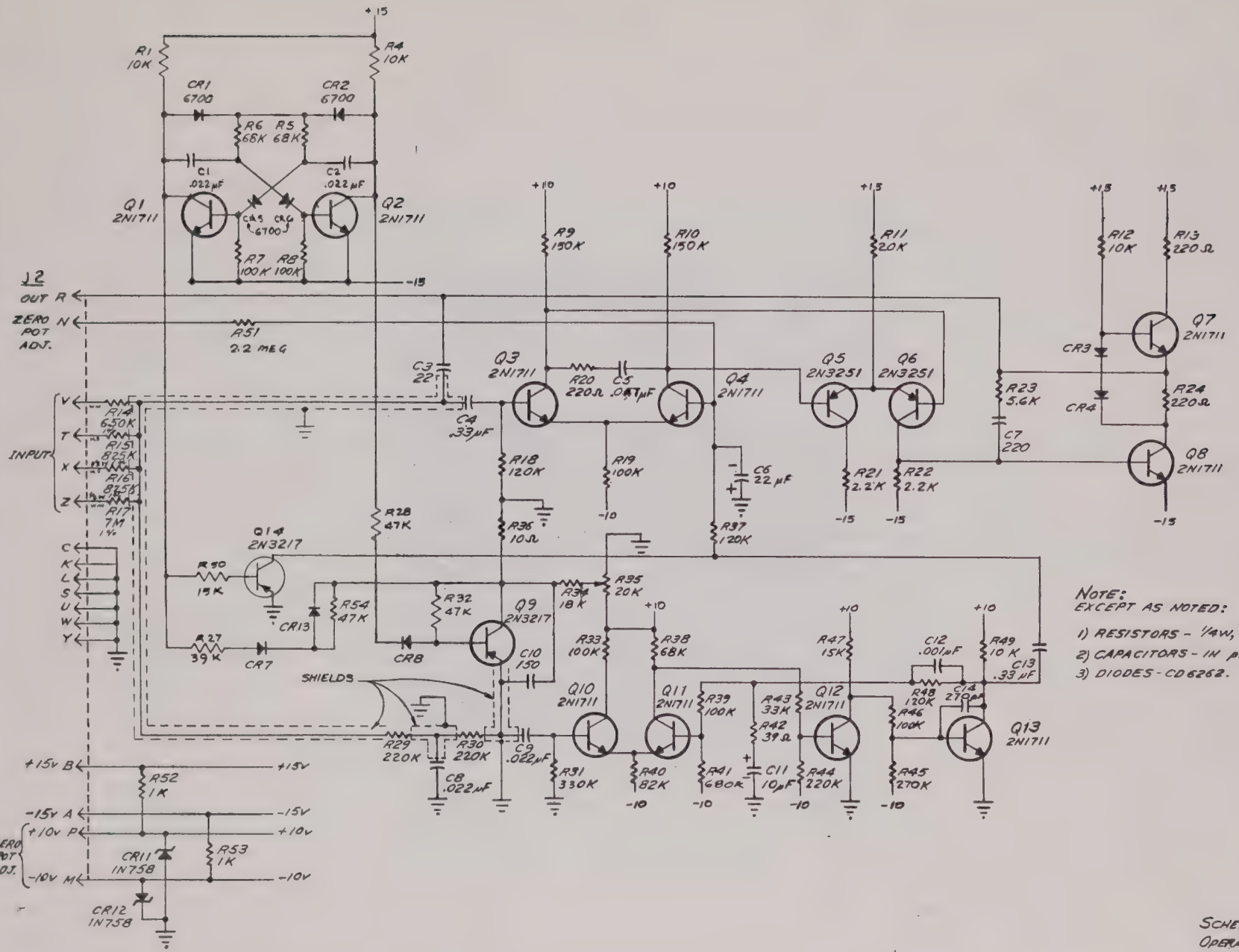


Figure 5-4. Switch PC Board Assembly and Schematic (Sheet 2 of 2)



NOTE:
EXCEPT AS NOTED:

1) RESISTORS - 1/4W, 5%.
2) CAPACITORS - IN μF.
3) DIODES - CD6262.

SCHEMATIC - OPERATIONAL AMPLIFIER

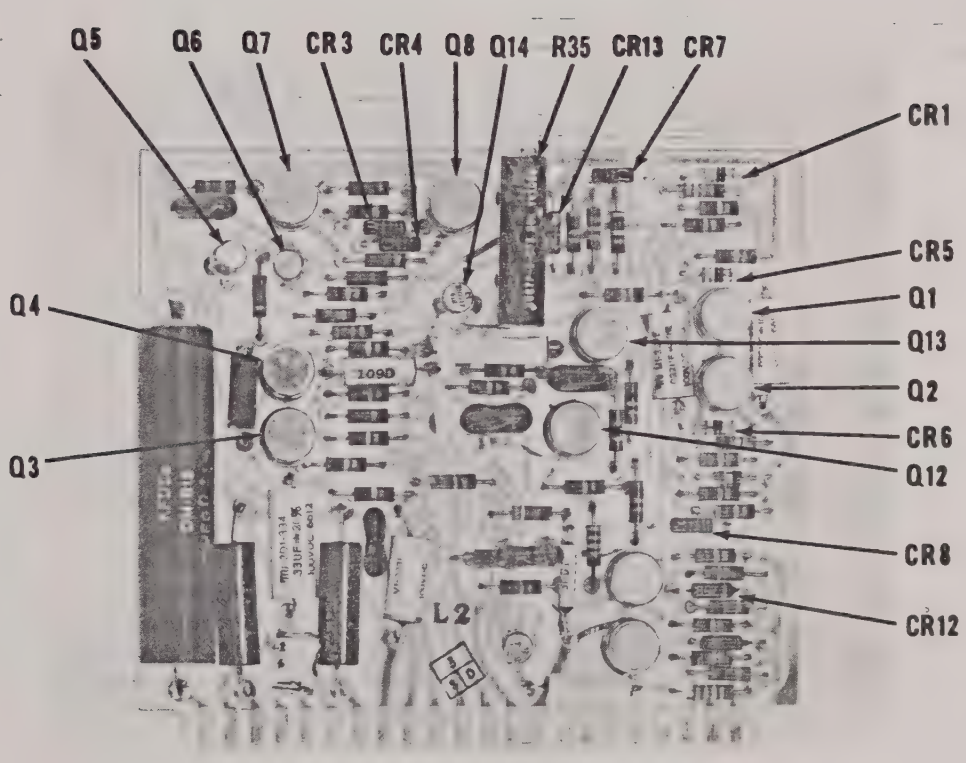
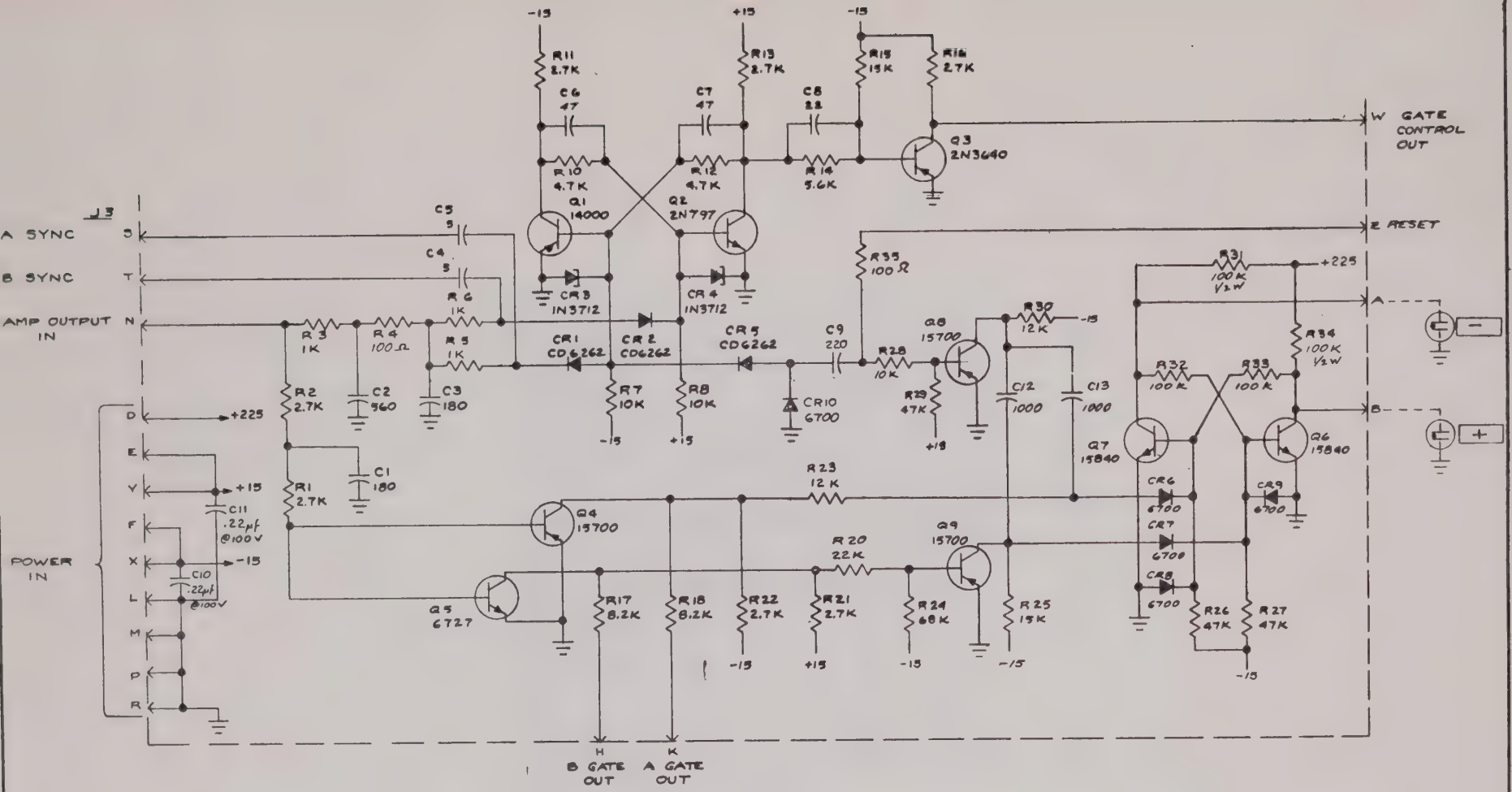


Figure 5-5. Operational Amplifier Assembly and Schematic (Sheet 2 of 2)



NOTE:
UNLESS OTHERWISE SPECIFIED -
1. RESISTORS ARE 1/4 W, ± 5%
2. CAPACITOR VALUES ARE IN pf.

SCHEMATIC
THRESHOLD
DETECTOR &
POLARITY
P.C. BOARD

17681 A

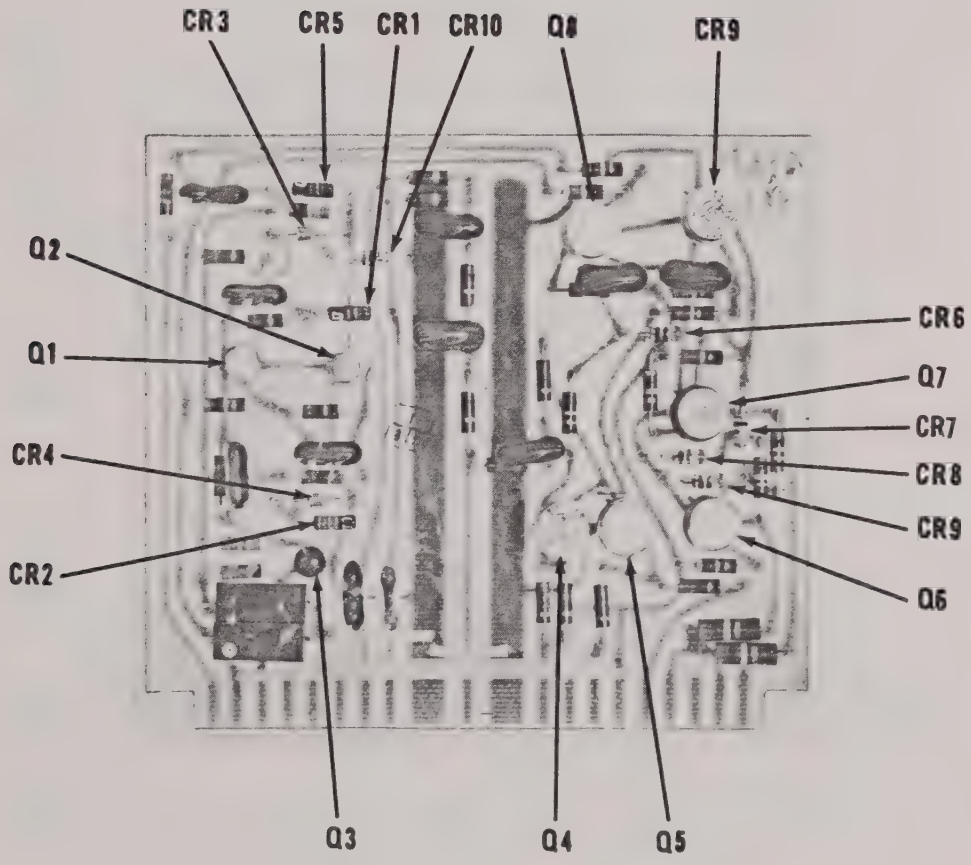
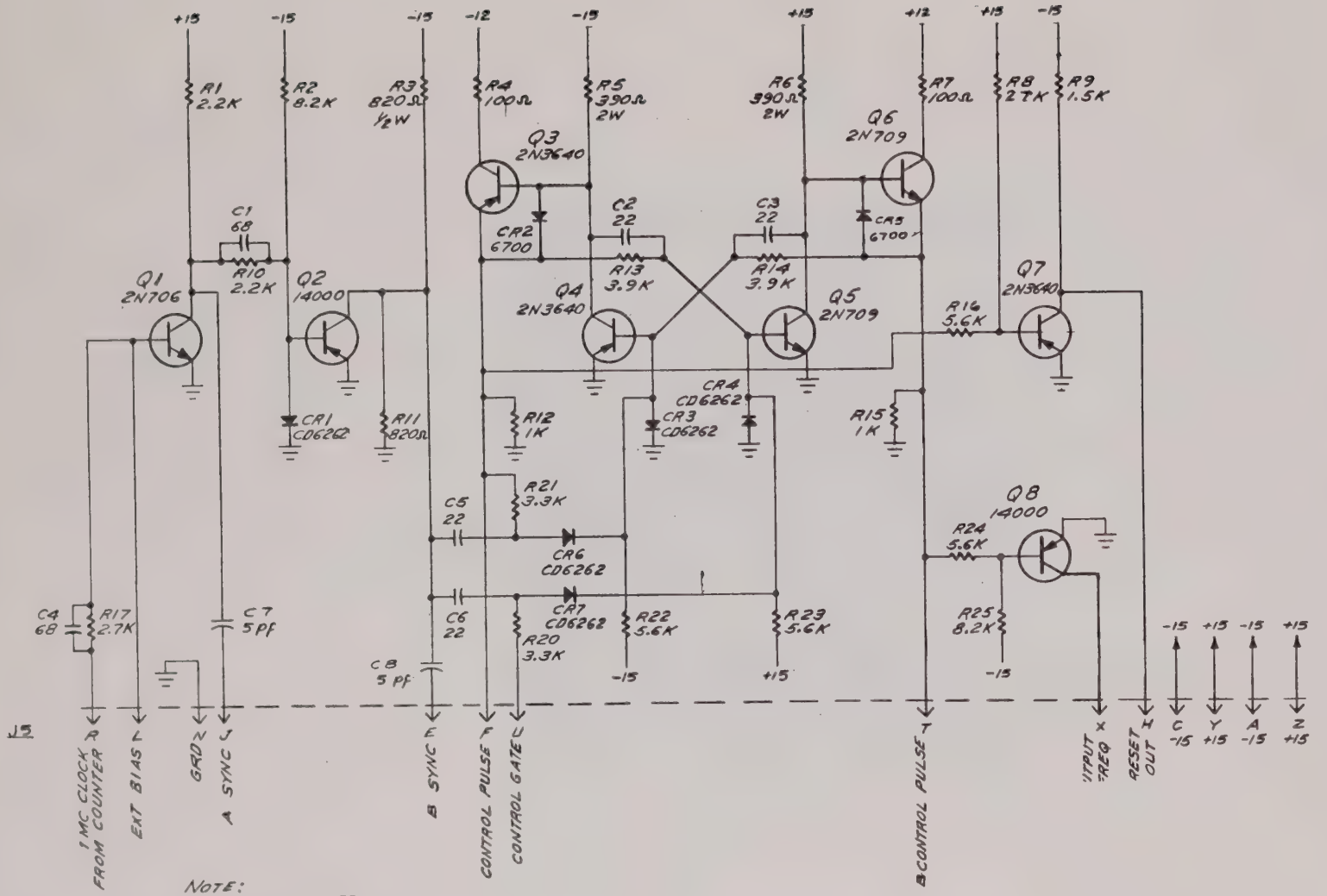


Figure 5-6. Threshold Detector and Polarity Detector Assembly and Schematic (Sheet 2 of 2)



NOTE:
EXCEPT AS NOTED.

1) RESISTORS ¼W 5%.
2) CAPACITORS IN pF.
3) 'A' IS ASSOCIATED WITH THE MEASUREMENT OF POSITIVE VOLTAGE, 'B' WITH NEGATIVE

SCHEMATIC-
PULSE
GENERATOR

17682 A

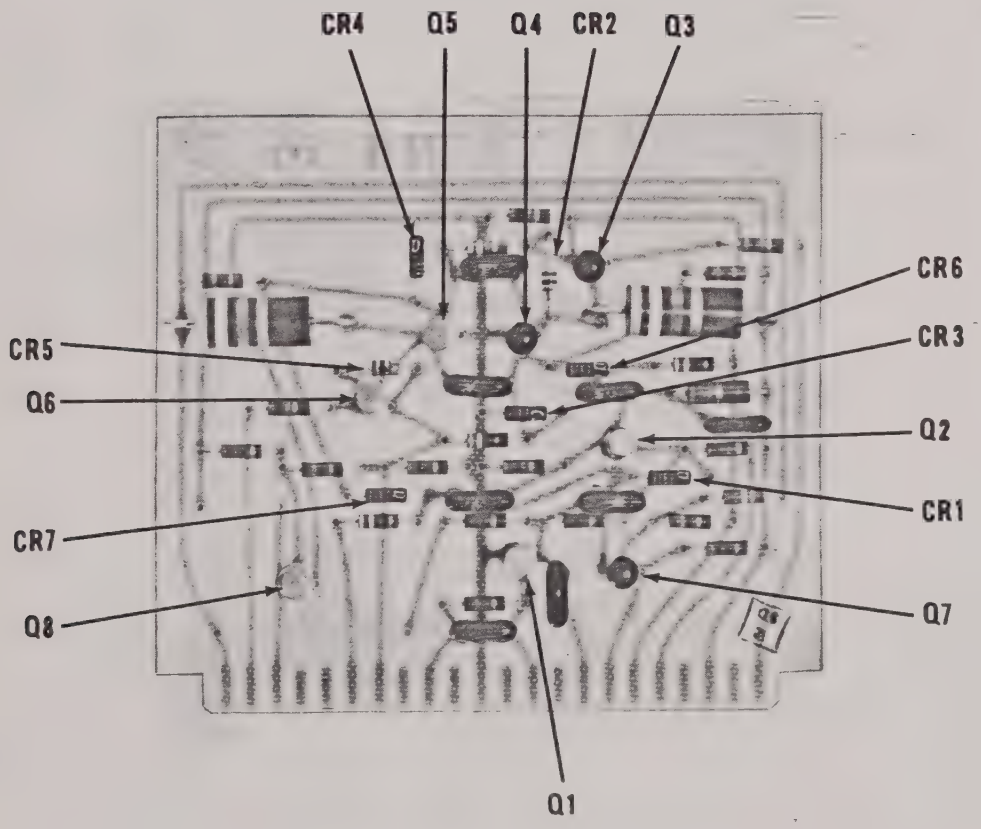
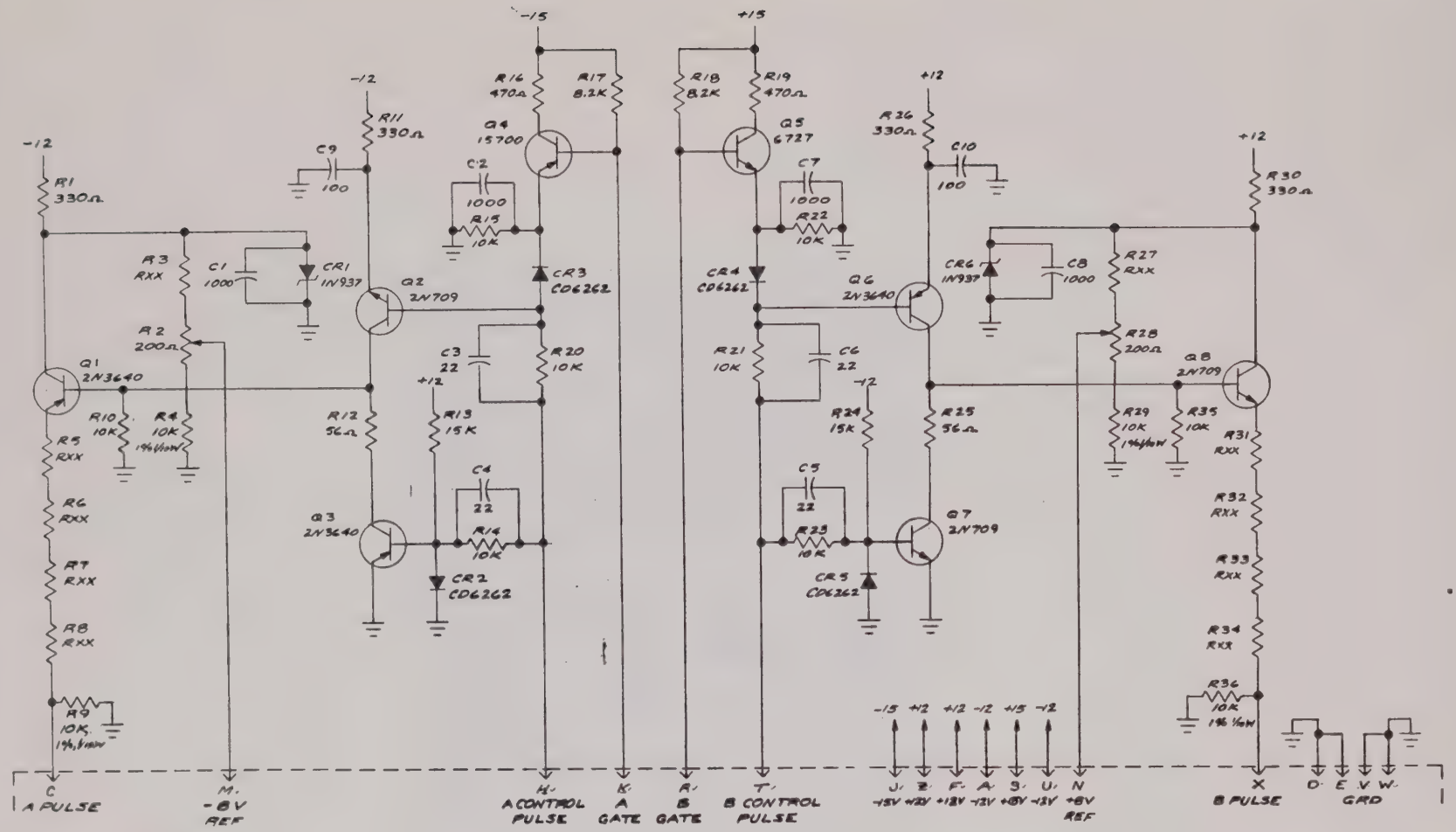


Figure 5-7. Pulse Generator Assembly and Schematic (Sheet 2 of 2)



NOTE:

UNLESS OTHERWISE SPECIFIED:

1. RESISTORS ARE 1/4W, 5%.
2. CAPACITORS ARE IN pF.
3. 'A' IS ASSOCIATED WITH POSITIVE VOLTAGE, 'B' WITH NEGATIVE VOLTAGE.
4. R5, R6, R31 & R32 ARE TEMP. COEF. TEXAS INSTRUMENT TYPE TM-1/4, TC=+.7%/°C. FOR PROPER TEMP. COMPENSATION.
5. R7 & R33 ARE METAL FILM AND ARE SELECTED FOR FULL SCALE (NOMINAL VALUE = 1K.)
6. R35 & R27 ARE METAL FILM (T.C. < 10 PPM/°C) AND ARE SELECTED TO PROVIDE PROPER ADJUSTMENT RANGE FOR THE +8V & -8V REF VOLTAGE.

SCHEMATIC
CHARGE
DISPENSER

17680 A

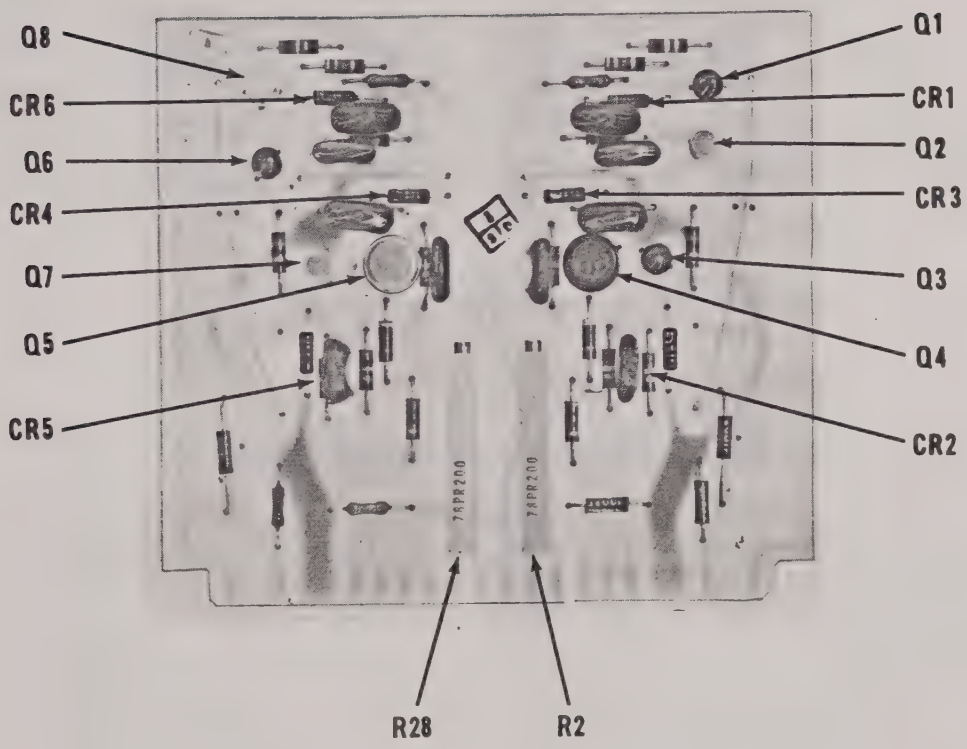


Figure 5-8. Charge Dispenser Assembly and Schematic (Sheet 2 of 2)

CHAPTER 6

REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts and assemblies. Tabel 6-1 provides a list of reference designators used in this manual. Table 6-2 groups all replaceable parts and assemblies under the headings of FINAL ASSEMBLY COMPONENTS, ELECTRICAL COMPONENTS, and MISCELLANEOUS PARTS; and lists these parts and assemblies in alpha-numerical order by Systron-Donner part number, grouping all similar items. This table provides description, manufacturer, manufacturer's part number, and quantity used per instrument, for all listed parts and assemblies, thereby simplifying customer spares provisioning. Figures 6-1 through 6-8 lists replaceable parts for each assembly in alpha-numerical order by reference designator, showing component location on each assembly, and cross-referencing component reference designator to Systron-Donner part number.

6-3. ORDERING INFORMATION

6-4. Address all orders or inquiries concerning replaceable parts or accessories to your local Systron-Donner Engineering Representative.

6-5. All orders or inquiries concerning replaceable parts should provide the following information:

a. Model and serial number of instrument (and assembly if applicable) for which part is required.

b. Systron-Donner part number of replaceable item.

c. Description and schematic reference designator of replaceable item.

6-6. To order a part not listed in Table 6-2, provide a complete description of the part, and describe its physical and functional placement in the instrument.

Table 6-1. Replaceable Parts

REFERENCE DESIGNATORS ABBREVIATION LIST

A	=	assembly	FL	=	filter	S	=	switch
AT	=	attenuator	J	=	jack	T	=	transformer
B	=	motor	K	=	relay	TC	=	thermocouple
BT	=	battery	L	=	inductor	TP	=	test jack
C	=	capacitor	M	=	meter	V	=	vacuum tube, neon bulb, photocell, etc.
CB	=	circuit breaker	MP	=	mechanical part	W	=	cable
DL	=	delay line	P	-	plug	X	=	socket
DS	=	device signaling (lamp)	Q	=	transistor	Y	=	crystal
E	=	misc. electronic part	R	=	resistor	Z	=	network
F	=	fuse	RT	-	thermistor			

Table 6-2. Master Parts List, Continued

SYS-DON. PART NO.	DESCRIPTION	MANUFACTURER - PART NO.
DIODES		
CR-0064	Type 1N752A, Zener 5.6v	
CR-0072	Type 1N759, 12v, silicon regular	Texas Instruments
CR-0095	Type 1N751A	
CR-0132	Type 1N716, Zener 12v, 1/4w	International Rectifier
CR-0148	Type DI-52	Diodes, Inc. DI-52
CR-0149	Type DI-54, silicon rectifier	Diodes, Inc. DI-54
CR-0150	Type CD 6262, silicon rectifier	Continental Devices
CR-0173	Type 1N3712, tunnel diode	General Electric
CR-0188	Type 1N3719, tunnel diode	General Electric
CR-0189	Type 1N3605, tunnel diode	General Electric
CR-0194	Type Q6-100	International Diode
CR-0224	Type 1N3030A, zener 27v, 5%, 1w	Motorola 1N3030A
CR-0228	Type 1N984B, zener	
6-6700	Type 6700, per S-D Spec.	
FUSE		
F-0019	Fuse, 1.5A Slo Blo	
F-0043	Fuse, 3AG, .25A, Quick Acting	Littlefuse 312-250
INDUCTORS		
L-0053	Choke, 6.8 uh	Essex WEE 6.8
L-0055	Coil, 24v	Coto Coil U-24P
13-15320-1	Inductor, Variable Assembly 1 uh	S-D Corp.
13-15320-2	Inductor, Variable Assembly 3.3 uh	S-D Corp.
TRANSISTORS		
Q-0028	Type 2N697	Fairchild
Q-0073	Type 2N1304	Texas Instruments
Q-0075	Type 2N1306	Texas Instruments
Q-0080	Type 2N1183	RCA
Q-0084	Type 2N1671B	G.E.
Q-0102	Type 2N2270	RCA
Q-0104	Type 2N2142	Motorola
Q-0130	Type 2N706	Philco
Q-0131	Type 2N2201	
Q-0136	3N58 Silicon	G.E.
Q-0157	Type 2N3251	Motorola
Q-0158	Type 2N2708	RCA
Q-0166	Type 40251	RCA
Q-0170	Type 2N1546	Motorola
Q-0171	Type 2N2146	Motorola
Q-0174	Type 2N3251	
Q-6724	Type 2N1302A	RCA
19-6727	Per S-D Spec.	2N1304 equivalent
19-14000	Transistor 14000, per S-D Spec.	2N964 equivalent
19-14092	Transistor 14092, per S-D Spec.	2N709 equivalent
19-15700	Transistor 15700, per S-D spec.	2N404 equivalent
19-15840	Transistor 15840, per S-D Spec.	2N3440 equivalent
19-15850	Transistor 15850, per S-D Spec.	2N3440 equivalent

RESISTORS

SYS-DON. PART NO.	DESCRIPTION
R-0136	3.3K, ±5%, 1/2w
R-0137	56K, ±5%, 1/2w
R-0143	2.7K, ±5%, 1/2w
R-0144	47K, ±5%, 1/2w
R-0150	1M, ±5%, 1/2w
R-0200	7.5K, ±5%, 1/2w
R-0230	43K, ±5%, 1/2w
R-0252	75K, ±5%, 1/2w
R-0259	2.2K, ±5%, 1/2w
R-0260	1.2K, ±5%, 1/2w
R-0263	330K, ±5%, 1/2w
R-0264	220K, ±5%, 1/2w
R-0265	1.5K, ±5%, 1/2w
R-0273	68K, ±5%, 1/23
R-0276	1K, ±5%, 1/2w
R-0277	1.8K, 5%, 1/2w
R-0278	1K, ±5%, 1/2w
R-0292	10K, ±5%, 1/2w
R-0293	120K, ±5%, 1/2w
R-0309	1.2K, 5%, 1/4w
R-0315	330Ω, 5%, 1/2w
R-0321	680Ω, ±5%, 1/2w
R-0330	1K, ±10%, 2s
R-0351	2.5K, ±5%, 1/2w
R-0352	100K, ±5%, 1/2w
R-0354	10Ω, ±5%, 1/2w
R-0355	150K, ±5%, 1/2w
R-0356	100K, ±5%, 1w
R-0365	270Ω, ±5%, 1/2w
R-0424	30Ω, ±5%, 1/2w
R-0431	110Ω, ±5%, 1/2w
R-0466	100Ω, ±5%, 1/2w
R-0472	8.2K, ±5%, 1/2w
R-0474	15K, ±5%, 1/2w
R-0479	91K, ±5%, 1/2w
R-0492	1.2K, ±10%, 1w
R-0514	6.8K, ±5%, 1/2w
R-0522	4.7K, ±5%, 1/2w
R-0527	22K, ±5%, 1/2w
R-0562	5.6K, ±5%, 1/2w
R-0564	27K, ±5%, 1/2w
R-0576	67K, ±5%, 1/2w
R-0585	36K, ±5%, 1/2w
R-0616	3.9K, ±5%, 1/2w
R-0619	27K, ±5%, 2w
R-0643	1.8K, ±10%, 1w
R-0662	330Ω, ±5%, 1/4w
R-0670	300Ω, ±5%, 1/4w
R-0677	470Ω, ±5%, 1/2w
R-0694	370Ω, ±5%, 1/4w
R-0695	43K, ±5%, 1/4w
R-0696	6.8K, ±5%, 1/4w
R-0702	4.3K, ±5%, 1/4w
R-0705	36K, ±5%, 1/4w
R-0711	3K, ±5%, 1/4w
R-0715	30K, ±5%, 1/4w
R-0720	3.3K, ±5%, 1/4w
R-0721	2.2K, ±5%, 1/4w
R-0724	39Ω, ±5%, 1/2w
R-0725	180Ω, ±5%, 1/2w
R-0728	15K, ±5%, 1/4w
R-0734	2K, ±5%, 1/4w
R-0736	200Ω, ±5%, 1/4w
R-0739	10Ω, ±5%, 1/4w
R-0741	100K, ±5%, 1/4w
R-0742	3.3K, ±5%, 1/4w
R-0743	47Ω, ±5%, 1/4w
R-0748	39K, ±5%, 1/4w
R-0749	2.2K, ±5%, 1/4w
R-0759	12K, ±5%, 1/4w
R-0760	220Ω, ±5%, 1/4w
R-0762	820Ω, ±5%, 1/4w
R-0765	1K, ±5%, 1/4w
R-0766	10K, ±5%, 1/4w
R-0768	22K, ±5%, 1/43
R-0776	9.1K, ±5%, 1/43
R-0777	47K, ±5%, 1/4w
R-0780	33K, ±5%, 1/4w
R-0783	1.5K, ±5%, 1/4w
R-0784	82K, ±5%, 1/4w
R-1287	Pot. 2w EZ Trip
R-1288	Trimpot, 1K, 1/2w, ±10%
R-1317	Pot. 500Ω, 1/2w, w.w. EZ trim
R-1498	100K, ±2%, 1/2w, metal film
R-1499	120K, ±2%, 1/2w, metal film
R-1596	22K, ±2%, 1w
R-1661	2Ω, 2w, wire wound
R-1665	Pot. 5K, ±30%, 1/4w
R-0785	18K, ±5%, 1/4w
R-0807	120K, ±5%, 1/4w
R-0809	1.2K, ±5%, 1/4w
R-0819	560Ω, ±5%, 1/4w
R-0821	5.6K, ±5%, 1/4w
R-0823	200K, ±5%, 1/4w
R-0824	27K, ±5%, 1/4w
R-0835	240Ω, ±5%, 1/4w
R-0875	100K, ±5%, 1/4w
R-0879	10K, ±5%, 1w
R-0880	390Ω, ±5%, 1/4w
R-0883	8.2K, ±5%, 1/4w
R-0884	7.5K, ±5%, 1/4w
R-0892	4.7K, ±5%, 1/4w
R-0937	2.7K, ±5%, 1/4w
R-0939	3.9K, ±5%, 1/4w
R-0962	1M, ±5%, 1/4w
R-0965	6.2K, ±5%, 1/4w
R-0966	100Ω, ±5%, 1/4w
R-0971	62K, ±5%, 1/4w
R-0976	75K, ±5%, 1/4w
R-0983	150Ω, ±5%, 1/4w
R-0984	510Ω, ±5%, 1/4w
R-1044	470Ω, ±5%, 1/4w
R-1059	82Ω, ±5%, 1/4w
R-1083	560Ω, ±5%, 1/2w
R-1113	10K, ±10%, 2w
R-1116	47K, ±5%, 2w
R-1233	180Ω, 1/4w, 5%
R-1234	680Ω, ±5%, 1/4w
R-1235	56K, ±5%, 1/4w
R-1246	51Ω, ±5%, 1/4w
R-1295	240Ω, ±5%, 2w
R-1313	30Ω, ±5%
R-1425	750Ω, ±5%, 1/4w
R-1436	
R-1549	30Ω, ±5%, 1/4w
R-1556	75Ω, ±5%, 1/4w
R-1571	360Ω, ±5%, 1/4w
R-1573	1K, ±5%, 2w
R-1589	36K, ±5%, 2w
R-1590	620Ω, ±5%, 1w
R-1593	1.8M ±5%, 1/4w 1
R-1667	430Ω, ±5%, 1/4w
R-1668	560Ω, ±5%, 1w
R-1669	1.1K, ±5%, 1w
R-1701	3K, ±5%, 1/2w
R-1868	270Ω, ±5%, 3w
R-1089	1K, ±5%, 1w

Unless otherwise noted, all resistors are composition carbon by Allen-Bradley.

TRANSFORMERS		Manufacturer
T-0083		
T-0084	1:1 T801	
T-0085	6:1 T802	
1-13516	Insulation, Trans.	S-D Corp.
9-15326	Foil, Trans.	S-D Corp.
23-12740	Transformer	Tranex 23-12740

Part No.	Description	Ref.
15452	FINAL ASSEMBLY	
15439	Panel, Front, Assembly	
15440	Panel, Front S.S. Assy	
15962	Time Base-Function Sw. Cable Assy	
15963	Time Base Sw. Jumper & Loose Wire Assembly	
15961	Wire Prep. Assy	
15964	Function Sw. Jumper & Loose Wire Assy	
17004	Wire Prep. Assy	
17002	Mother Bd #1 PC Bd Assy	
16155	Loose Wire Prep. Assy	
15459	Annunciator Assy	
15718	Range Sw. Level Control Cable Assy	
15455	Rear Panel Assy	
15448	Power Supply Assy	
15965	Connector J1 Cable Assy	
15966	Wire Prep. Assy	
15412	Power Supply PC Bd Assy	
15458	Mother Bd #2 PC Bd Assy	
15394	Chassis Assembly	
16152	Connector J7 Cable Assy	
16151	Wire Prep. Assy	
10504	250KC Stand. Decade PC Bd Assy	
13269	2.5MC Stand. Decade PC Bd Assy	
15116	10MC Stand. Decade PC Bd Assy	
12242	50MC Readout Decade PC Bd Assy	
15391	Display & Reset PC Bd Assy	
11095	Multiplier & Osc. PC Bd Assy	
13534	50MC Amplifier PC Bd Assy	
15422	Time Base PC Bd Assy	
11523	250KC Storage Decade PC Bd Assy	
11527	2.5MC Storage Decade PC Bd Assy	
15200	10MC Storage Decade PC Bd Assy	
12970	50MC Readout Decade PC Bd Assy	
12983	Multiply + 3 PC Bd Assy	
12970	Power Supply PC Bd Assy	
15439	FRONT PANEL ASSEMBLY	
15440	Panel, Front, S.S. Assy	
15581	Art Work	
15415	Panel Front	
17007	Panel, Front Blank	
15962	Time Base-Function Sw. Cable Assy	
15963	Time Base Sw. Jumper & Loose Wire Assy	
15213	Time Base Sw	S1
15961	Wire Prep. Assy	
16141	Wire PVC, per Std Wire List	
15964	Function Sw. Jumper & Loose Wire Assy	
15214	Function Switch	S2
17004	Wire Prep. Assy	
16141	Wire #22 PVC per Std. Wire, Coax RG-196/U	
H-0955	Ferrule	
TS-0024	Thermal Sleeving	
H1104	Cable Tie	
16155	Loose Wire Prep. Assy	
15459	Annunciator Assy	
15718	Range Sw-Level Control Cable	
E-0137	Lug, Ground, BNC Type	
11342	Lock, Panel	
13548	Knob, Black, 1/4" dia. shaft	
13547	Knob, Black, 1/8" dia. shaft	
J-0260	Connector, BNC	J2
S-0073	Switch, Toggle, DPDT	S7
S-0140	Switch, Pushbutton SPST	S8
11637	Knob Spec. Dual Control	
11636	Knob Spec. Single Shaft	
15404	Bracket, Window	
11066	Window	
15405	Bracket, PC Mtg.	
I-0055	Lamp, Pilot w/33K 1/4w Res. amber	I1
I-0047	Lamp, Pilot 3/150K 1/2w Res. Red	I2
H-1271	Screw, Tapping #2x1/4" Type B	
H-0988	Screw, Flat Hd. 6-32x1/2 Ph NPS	
H-1282	Washer, Lock #4 Int Tooth CPS	
H-1273	Screw Pan Hd 4-40x5/16 Ph CPS	
H-0984	Screw Pan Hd 6-32x3/8 Ph CPS	
H-0410	Washer, Lock #6 Int. Tooth CPS	

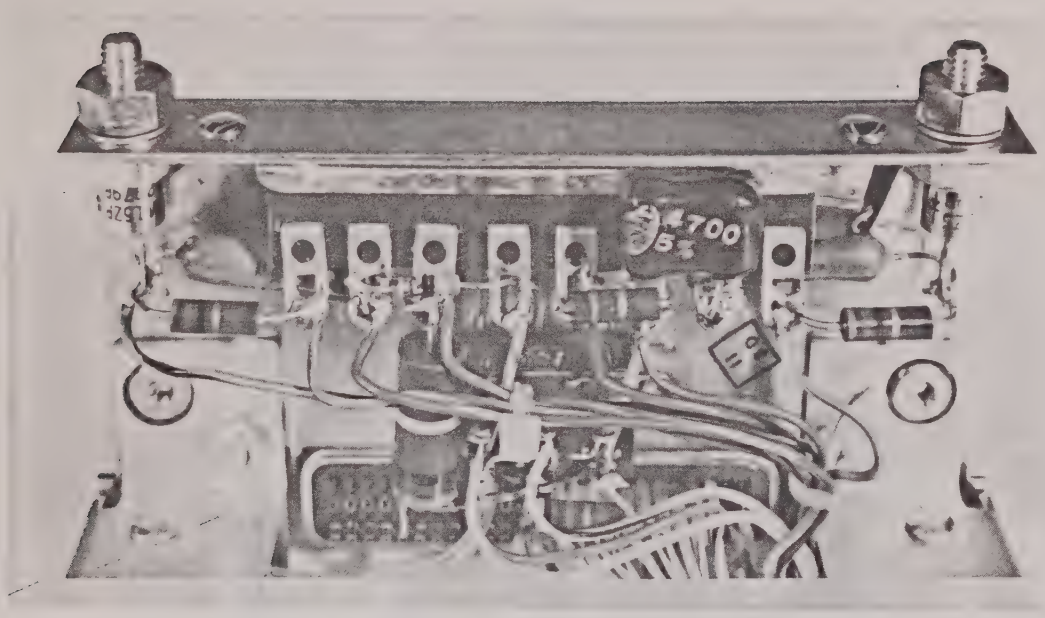
Part No.	Description	Ref.
17002	MOTHER BOARD NO. 1 PC ASS'Y	
16160	Mother Bd #1 PC Board	
17000	Artwork Mother Bd #1	
16046	Insulator, Socket	
X-0078	Socket, 9 Contacts	
J-0262	Connector, 20 Contacts	
13550	Connector, 12 Contacts	
10052	Indicator	I8
		I9
		I10
		I11
	Same as I8	I12
15455	REAR PANEL ASSEMBLY	
15658	Panel, Rear SS Assy	
12876	Artwork	
15456	Panel, Rear Welding Assy	
15457	Panel, Rear	
H-0390	Weld Nut 4-40	
H-03969	Weld Nut 6-32	
11115	Screen	
11096	Plug Plate	
15681	Fan Guard Assy	
15679	Cover, Fan Guard	
15680	Screen, Fan Guard	
15711	Fan Motor & Blade Assy	B1
B-0013-1	Fan Motor	
B-0013-2	Fan Blade	
B-0013-3	Screw 3-48	
15969	Rear Panel Cable Assy	
15970	Wire Prep. Assy	
	Wire Belden 8451 2 Cond.	
	Wire, Coas R6-196/U	
	Wire, 22 Ga PVC per wire std. 16141	
40955	Ferrule	
TS-0024	Thermal Sleeving	
H-1104	Cable Tie	
W-0004	Cord, AC Line	
X-0034	Holder, Fuse	
J-0260	Connector, BNC	J3
S-0110	Switch Slide, DPDT	S4
	Same as Se	S6
E-0137	Lug Ground, BNC Type	
H-0383	Heyco Nut	
H-0404	Rivet 1/8 dia 1/8 long	
H-0819	Screw, Pan Hd. 4-40x3/4 NPS	
H-1049	Screw, Pan Hd. 6-32x1/2 NPS	
H-0657	Screw, Pan Hd. 4-40x5/16 NPS	
H-0410	Washer, Lock #6 Int. tooth CPS	
H-0248	Washer, Lock #4 Int. tooth NPS	
15458	MOTHER BOARD NO. 2 P.C. ASS'Y	
16159	Mother Bd #2 PC Board	
17001	Artwork	
X-0103	Socket Octal	
J-0228	Connector, 22 Contacts	
J-0272	Connector, 15 Contacts	
E-0191	Terminal (18 Ga Wire)	
C-0424	Capacitor, .001 mfd 500v Disc	C1
C-0441	Capacitor, .01 mfd	C8

SYS-DON PART NO.	DESCRIPTION	MANUFACTURER - PART NO.
MISCELLANEOUS		
E-0100	Terminal, Space Lug P.C.	USECO
E-0112	Solder Lug #8, Int. Tooth	
E-0146		
E-0184	Coil Forms with Adj. Core	Delevan Elec. DEL 6/C
H-0146	Transistor Pad Coupling, Solid	Pacific Wholesale
H-0376	Screw, 4-40x3/8"Cad. Plt'd BHMS	
H-0481		
H-0515	Transistor Mtg Pad	Delbert Blinn TP 501
H-0516	Screw, Mach. 6-32x1-1/2" CPS	
H-0606	Grommet 1/2" dia mtg	Rubbercraft
H-0658	Washer, Int. Tooth #8, .33 OD nom. x1/64"	
H-0726		
H-0727		
H-0746	Washer, Lock, Int. tooth #6 CPS	
H-0749	Nut, 6-32 lug, Pattern C.P.S.	
H-0791		
H-0940	Drive Rivets, Aluminum S.S. Pins	Southco 38-104-06-13
H-0941	Nylon Bushing 6x1/4" length	Machine Part Co., N.Y.
H-0980		
H-1033	Screw, 8-32x3/8, C.P.S., Phillip hd	
H-1055	Thermal Compound	Wakefield 122
H-1104		
H-1155	Washer, Shldr 5/16", Fiber #6	G.C. #6525C
K-0082	Relay	
X-0094	Relay Socket	
I -0041	Lamp	
J-0170	Connector 50 pin (See P/L 17013)	
S-0132	Reed Relay Contacts, N.O., Magnetic Reed	Gordos Corp MR400-1
X-0127	Fuse Holder for 3AG fuses, 5 pole	Littlefuse 357005
9669	PC Bd. Stiffener	
11529	PC Bd (10MC)	
12241	50MC Readout Bd.	
13269		
14599-1		
14899-1		
15200	10MC Storage Decade Assy	
15371	SS Assy	
15674	1-2-4-8 Option Bd	

SYS-DON PART NO.	DESCRIPTION	MANUFACTURER - PART NO.
CAPACITORS		
C-0235	.001 uf, 3/8" max.	Centralab DD102
C-0325	.005 mf, 10%, 150v, ceramic disc	Centralab DDM-502
C-0354	.22 uf, 20%, 35v	Astron TESP-22-35
C-0406	4.7 uf, 35v, solid tant.	Texas Instru. SCM475BP035A4
C-0417	4 uf, 30v, tant. +75 -15%	G.E. 62F208
C-0441	.01 uf, 400v, ±20%, mylar foil	Hopkins P014MF
C-0524	1.0 uf, 35v, ±20%, tant.	Texas Instru. SCM105FP035D4
C-0527	10 pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-100K-500v
C-0528	15pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-150K-500v
C-0529	22pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-220K-500v
C-0530	27pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-270K-500v
C-0531	33pf, 10%, 500v, dipped silver mica	ElMenco DM-15E-470K-500v
C-0533	47pf, ±10%, 500v, dipped silver mica	ElMenco DM-15E-820K-500v
C-0535	82pf, 10%, 500v, dipped silver mica	ElMenco DM-15E-820K-500v
C-0536	100pf, 10%, 500v, dipped silver mica	ElMenco DM-15F-101K-500v
C-0537	150pf, 10%, 500v, dipped silver mica	ElMenco DM-15F-151K-500v
C-0538	220pf, ±10%, 500v, dipped silver mica	ElMenco DM-15F-221K-500v
C-0539	270pf, 10%, 500v, dipped silver mica	ElMenco DM-15F-271K-500v
C-0540	330pf, ±10%, 500v, dipped silver mica	ElMenco DM-15F-331K-500v
C-0541	390pf, ±10%, 500v, dipped silver mica	ElMenco DM-15F-391K-500v
C-0542	470pf, ±10%, 300v, dipped silver mica	ElMenco DM-15F-470K-300v
C-0543	1000pf, ±10%, 100v, dipped silver mica	ElMenco DM-15F-102K-100v
C-0544	2000pf, ±10%, 500v, dipped silver mica	Mica Mold MOC-202K
C-0562	.01uf, +80 -20%, 50v ceramic disc	Sprague 19C214
C-0564	.10uf, ±20%, 100v. metalized paper	Electron ME1-104
C-0596	5 pf, 10%, 500v, dipped silver mica	ElMenco DM-15C-050-500v
C-0628	100pf, 10%, 500v, dipped silver mica	ElMenco DM-19F-101K-500v
C-0632	.25 uf, 5%, 100v, mylar	Hopkins P252MC
C-0635	68 pf, ±10%, 500v, dipped silver mica	ElMenco DM-15E-680K-500v
C-0636	680pf, ±10%, 300v, dipped silver mica	Mica Mold MQ-C681K
C-0643	180pf, 10%, 500v, dipped silver mica	ElMenco DM15F-181K-500v
C-0661	0.1uf, ±20%, 10v, ceramic disc	C.R.L. UJ10-104
C-0664	20uf, ±10%, 50v electrolytic	Sprague 40D195A2
C-0672	.05 uf, +80 -20% 12v, disc	Magnacap R.M.C.
C-0681	820pf, 10%, 300v, dipped silver mica	ElMenco DM-15F-821K-300v
C-0705	.01uf, 10%, 50v metalized mylar	G.E. 65F10AC103
C-0706		
C-0708	.05uf, +80 -20%, 50v, ceramic disc	Sprague 55C23
C-0709	9 - 35 pf, trimmer	Erie 538-011-E2PO-94R
C-0712	5.5 - 18 pf, trimmer	Erie 538-011-NP05.5-18
C-0732	120 uf, ±20%, 10v	Kenet K120P10
C-0733	.47 uf, 35 - 42v, 20%, tant. solid	G.I. MCSF4-74M
C-0759	3000 pfd, 5%, 500v, dipped silver mica	Arco DM19-302J
C-0760	1500 pf, 5%, 500v, dipped silver mica	Arco DM19-152J
C-0800	1000 uf (each) 50v, double	Sangamo Elec. 505-3802-01
5-13490	1000 uf, 65v	Sprague C-13490
5-13491	33 ufd, 400v	Sprague C-13491

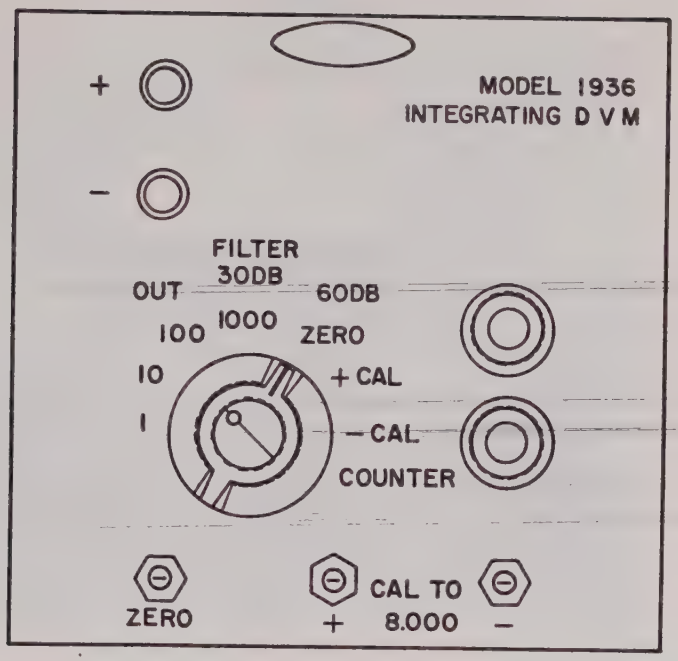
REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
CR1	N/A	CR0268
CR2	N/A	CR0268
J2	N/A	J0341
J3	N/A	J0341
J4	N/A	J0341
J5	N/A	J0341
MISCELLANEOUS		
CHASSIS	N/A	17625
NUT	N/A	H0249
SCREW	N/A	H0440
SHIELD, PC BOARD	N/A	17626
SOLDER LUG	N/A	E0193
WASHER	N/A	H5029
RIVET	N/A	H1174

Figure 6-1. Chassis Assembly Replaceable Parts



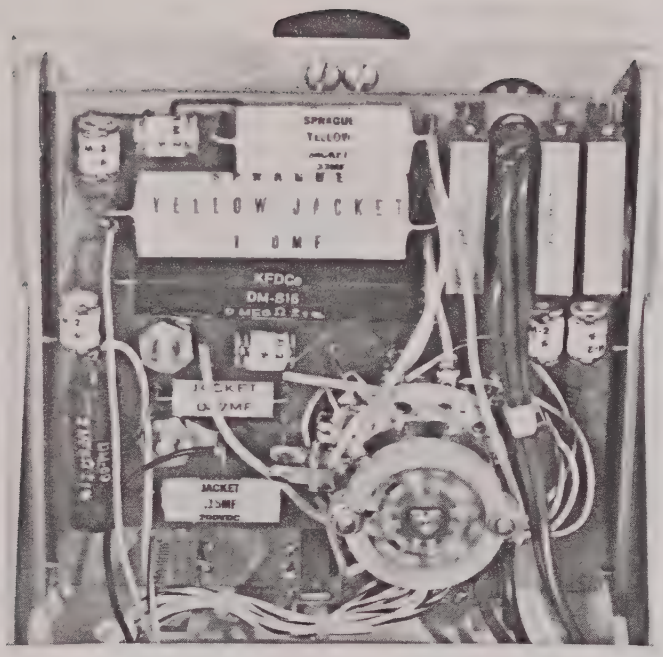
REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
C1	N/A	CO633
CR3	N/A	CR0266
CR4	N/A	CR0267
CR5	N/A	6700
P1	N/A	J0261
R4	N/A	R1044
R5	N/A	R0201
R6	N/A	R0201
R7	N/A	R2116
R8	N/A	R2116
R9	N/A	R0156
R10	N/A	R0330
R11	N/A	R0966
R12	N/A	R0760
R13	N/A	R0760
S3	N/A	S0110
MISCELLANEOUS		
REAR MOUNTING BRACKET	N/A	19364
TERMINAL STRIP	N/A	E0193
WELD NUT	N/A	H0390

Figure 6-2. Rear Mounting Bracket Assembly Replaceable Parts



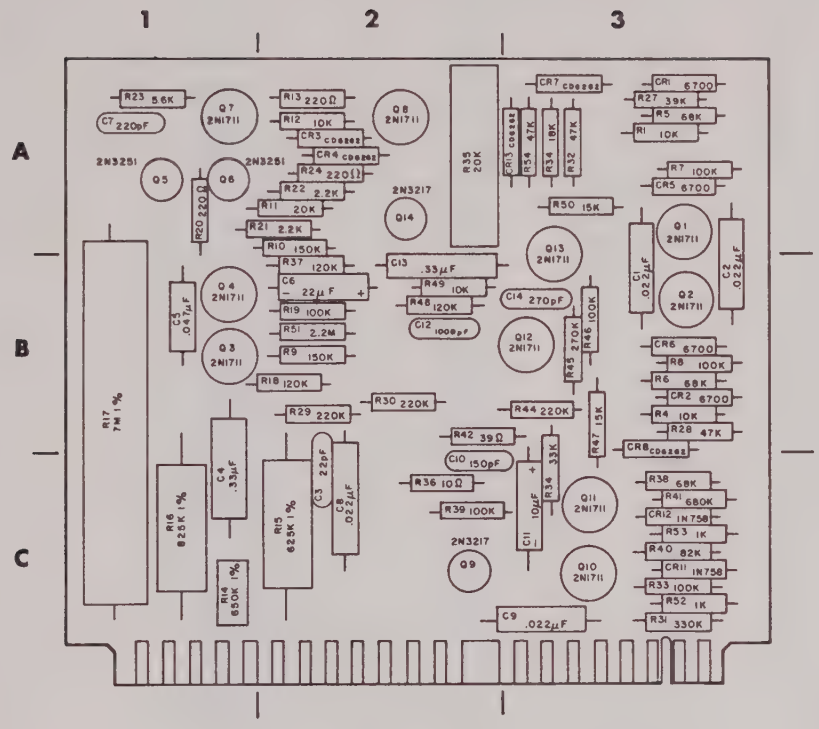
REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
I1	N/A	I0064
I2	N/A	I0064
R1	N/A	R2216
R2	N/A	R2216
R3	N/A	R2216
MISCELLANEOUS		
BINDING POST, BLACK	N/A	E0220
BINDING POST, RED	N/A	E0219
FRONT PANEL	N/A	17492
KNOB, CONCENTRIC LOWER, 1/4" SHAFT	N/A	H1300
KNOB, CONCENTRIC UPPER, 1/8" SHAFT	N/A	N1297
PANEL PULL	N/A	16018
SCREW	N/A	H0656
SOLDER LUG	N/A	E0120
TINNERMAN SPEED NUT	N/A	I0040
WASHER, SPLIT LOCK	N/A	H6076

Figure 6-3. Front Panel Assembly Replaceable Parts



REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
C1	N/A	C0886
C2	N/A	C0884
C3	N/A	C0887
C4	N/A	C0885
R1	N/A	R2127
R2	N/A	R2125
R3	N/A	R2124
R4	N/A	R2123
R5	N/A	R2122
R6	N/A	R2121
R7	N/A	R2120
R8	N/A	R2127
R9	N/A	R1211
R10	N/A	R2119
R11	N/A	R2118
S1 and S2	N/A	17654
TP1	N/A	E0100
TP2	N/A	E0100
MISCELLANEOUS		
PC BOARD	N/A	17659

Figure 6-4. Switch PC Board Assembly Replaceable Parts

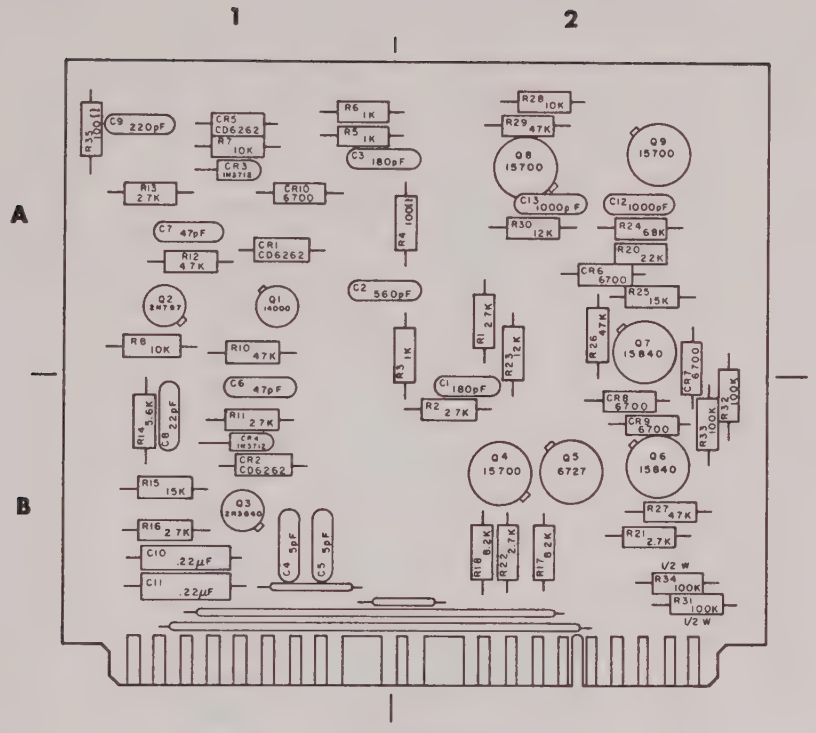


REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.	REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
C1	A3-B3	CO411	CR4	A2	CR0150
C2	A3-B3	CO411	CR5	A3	6700
C3	C2	CO378	CR6	B3	6700
C4	C1	CO767	CR7	A3	CR0150
C5	B1	CO788	CR8	B3	CR0150
C6	B2	CO371	CR9	N/A	Not Used
C7	A1	CO538	CR10	N/A	Not Used
C8	C2	CO411	CR11	C3	CR0112
C9	C3	CO411	CR12	C3	CR0112
C10	C2	CO537	CR13	A3	CR0150
C11	C3	CO510	Q1	A3	Q0140
C12	B2	CO543	Q2	B3	Q0140
C13	B2	CO767	Q3	B1	Q0140
C14	B3	CO539	Q4	B1	Q0140
CR1	A3	6700	Q5	A1	Q0174
CR2	B3	6700	Q6	A1	Q0174
CR3	A2	CR0150	Q7	A1	Q0140

Figure 6-5. Operational Amplifier Assembly Replaceable Parts (Sheet 1 of 2)

REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
Q8	A2	Q0140
Q9	C2	Q0160
Q10	C3	Q0140
Q11	C3	Q0140
Q12	B3	Q0140
Q13	A3-B3	Q0140
Q14	A2	Q0160
R1	A3	R0766
R2	N/A	Not Used
R3	N/A	Not Used
R4	B3	R0766
R5	A3	R0891
R6	B3	R0891
R7	A3	R0741
R8	B3	R0741
R9	B2	R0961
R10	A2	R0961
R11	A2	R0964
R12	A2	R0766
R13	A2	R0760
R14	C1	R2117
R15	C2	R2184
R16	C1	R2184
R17	B1-C1	R2126
R18	B2	R0807
R19	B2	R0741
R20	A1	R0760
R21	A2	R0749
R22	A2	R0749
R23	A1	R0821
R24	A2	R0760
R25	N/A	Not Used
R26	N/A	Not Used
R27	A3	R0748
R28	B3	R0777
R29	B2	R0967
R30	B2	R0967
R31	C3	R1203
R32	A3	R0777
R33	C3	R0741
R34	A3	R0785
R35	A2	R1303
R36	C2	R0739
R37	B2	R0807
R38	C3	R0891
R39	C2	R0741
R40	C3	R0784
R41	C3	R1274
R42	B2	R1552
R43	C3	R0780
R44	B3	R0967
R45	B3	R1622
R46	B3	R0741
R47	B3	R0728
R48	B2	R0807
R49	B2	R0766
R50	A3	R0728
R51	B2	R1014
R52	C3	R0765
R53	C3	R0765
R54	A3	R0777
MISCELLANEOUS		
TRANSISTOR PAD	N/A	H0515
PC BOARD	N/A	17719

Figure 6-5. Operational Amplifier Assembly Replaceable Parts (Sheet 2 of 2)



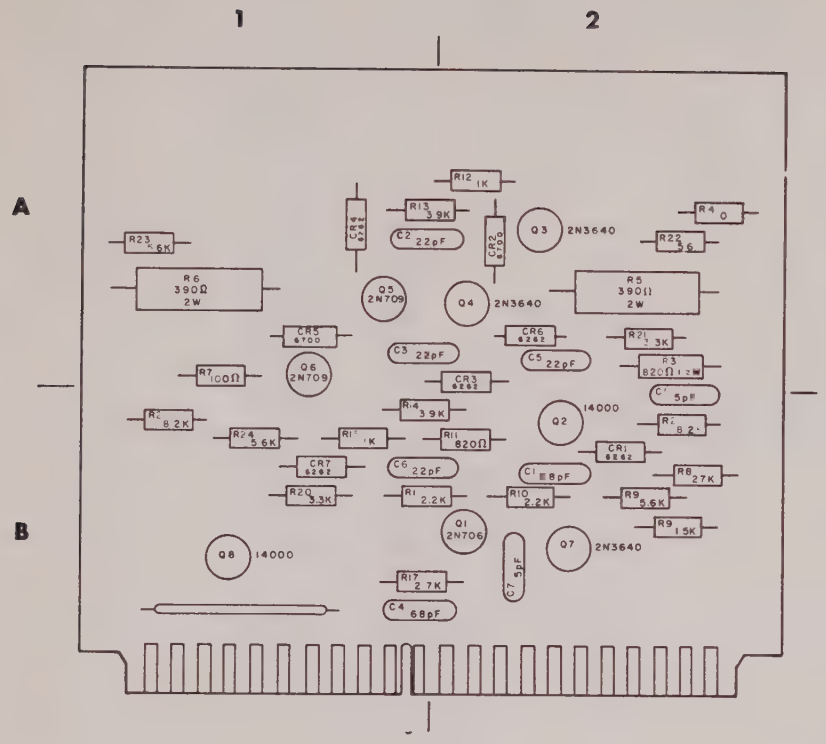
REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
C1	B2	C0643
C2	A1	C0644
C3	A1	C0643
C4	B1	C0596
C5	B1	C0596
C6	B1	C0533
C7	A1	C0533
C8	B1	C0529
C9	A1	C0538
C10	B1	C0787
C11	B1	C0787
C12	A2	C0787
C13	A2	C0543
CR1	A1	CR0150
CR2	B1	CR0150
CR3	A1	CR0173
CR4	B1	CR0173

REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
CR5	A1	CR0150
CR6	A2	6700
CR7	A2	6700
CR8	B2	6700
CR9	B2	6700
CR10	A1	6700
Q1	A1	14000
Q2	A1	Q0196
Q3	B1	Q0178
Q4	B2	15700
Q5	B2	6727
Q6	B2	15840
Q7	A2	15840
Q8	A2	15700
Q9	A2	15700
R1	A2	R0937
R2	B2	R0937

Figure 6-6. Threshold Detector and Polarity Assembly Replaceable Parts (Sheet 1 of 2)

REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
R3	A2	R0765
R4	A2	R0966
R5	A1	R0765
R6	A1	R0765
R7	A1	R0766
R8	A1	R0766
R9	N/A	Not Used
R10	A1	R0892
R11	B1	R0937
R12	A1	R0892
R13	A1	R0937
R14	B1	R0821
R15	B1	R0728
R16	B1	R0937
R17	B2	R0883
R18	B2	R0883
R19	N/A	Not Used
R20	A2	R0768
R21	B2	R0937
R22	B2	R0937
R23	A2	R0759
R24	A2	R0891
R25	A2	R0728
R26	A2	R0777
R27	B2	R0777
R28	A2	R0766
R29	A2	R0777
R30	A2	R0759
R31	B2	R0352
R32	B2	R0741
R33	B2	R0741
R34	B2	R0352
R35	A1	R0966
MISCELLANEOUS		
TRANSISTOR PAD	N/A	H0515
PC BOARD	N/A	17675

Figure 6-6. Threshold Detector and Polarity Assembly Replaceable Parts (Sheet 2 of 2)



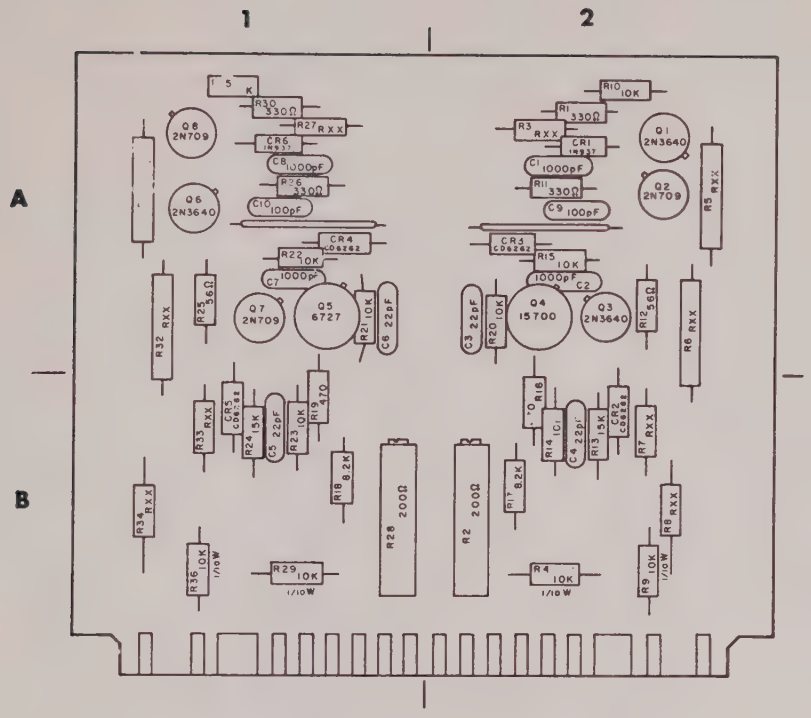
REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.	REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
C1	B2	C0535	Q1	B2	Q0130
C2	A2	C0378	Q2	B2	14000
C3	A2	C0378	Q3	A2	Q0178
C4	B2	C0535	Q4	A2	Q0178
C5	A2	C0378	Q5	A1	Q0152
C6	B2	C0378	Q6	A1	Q01 2
C7	B2	C0596	Q7	B2	Q0178
C8	A2	C0596	Q8	B1	14000
CR1	B2	CR0150	R1	B2	R0749
CR2	A2	6700	R2	B2	R0883
CR3	A2	CR0150	R3	A2	R1156
CR4	A1	CR0150	R4	A2	R0966
CR5	A1	6700	R5	A2	R 202
CR6	A2	CR0150	R6	A1	R0202
CR7	B1	CR0150	R7	A1	R0966

Figure 6-7. Pulse Generator Assembly Replaceable Parts (Sheet 1 of 2)

REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
R8	B2	R0824
R9	B2	R0783
R10	B2	R0749
R11	B2	R0762
R12	A2	R0765
R13	A2	R0939
R14	B2	R0939
R15	B1	R0765
R16	B2	R0821
R17	B2	R0937
R18	N/A	Not Used
R19	N/A	Not Used
R20	B1	R0720

REFERENCE DEISGNATOR	COMPONENT LOCATION	S-D PART NO.
R21	A2	R0720
R22	A2	R0821
R23	A1	R0821
R24	B1	R0821
R25	B1	R0883
MISCELLANEOUS		
PC BOARD	N/A	17676

Figure 6-7. Pulse Generator Assembly Replaceable Parts (Sheet 2 of 2)



REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
C1	A2	C0543
C2	A2	C0543
C3	A2	C0378
C4	B2	C0378
C5	B1	C0378
C6	A1	C0378
C7	A1	C0543
C8	A1	C0543
C9	A2	C0536
C10	A1	C0536
CR1	A2	CR0109
CR2	B2	CR0150
CR3	A2	CR0150
CR4	A1	CR0150
CR5	B1	CR0150
CR6	A1	CR0109

REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
Q1	A2	Q0178
Q2	A2	Q0152
Q3	A2	Q0178
Q4	A2	15700
Q5	A1	6727
Q6	A1	Q0178
Q7	A1	Q0152
Q8	A1	Q0152
R1	A2	R0662
R2	B2	R2215
*R3	A2	R2165
		R1721
		R2170
		R2171
R4	B2	R1479

Figure 6-8. Charge Dispenser Assembly Replaceable Parts (Sheet 1 of 2

REFERENCE DESIGNATOR	COMPONENT LOCATION	S-D PART NO.
*R5	A2	R2159
		R2160
		R2161
		R2162
		R2163
		R2164
*R6	A2	R2156
		R2157
*R7	B2	R2166
		R2169
		R2167
		R1980
		R2168
*R8	B2	R2086
		R2158
R9	B2	R1479
R10	A2	R0766
R11	A2	R0662
R12	A2	R1554
R13	B2	R0728
R14	B2	R0766
R15	A2	R0766
R16	B2	R1044
R17	B2	R0883
R18	B1	R0883
R19	B1	R1044
R20	A2	R0766
R21	A1	R0766
R22	A1	R0766
R23	B1	R0766
R24	B1	R0728
R25	A1	R1554
R26	A1	R0662
*R27	A1	R2165
		R1721
		R2170
		R2171
R28	B1	R2215
R29	B1	R1479
R30	A1	R0662
*R31	A1	R2159
		R2160
		R2161
		R2162
		R2163
		R2164
*R32	A1	R2156
		R2157
*R33	B1	R2166
		R2169
		R2167
		R1980
		R2168
*R34	B1	R2086
		R2158
R35	A1	R0766
R36	B1	R1479

MISCELLANEOUS		
TRANSISTOR PAD	N/A	H0515
PC BOARD	N/A	17674

*These resistors are factory selected components, and may be any of the listed values. Note the value of resistors installed in your instrument, and consult the master parts list to determine proper Systron-Donner part number.

Figure 6-8. Charge Dispenser Assembly Replaceable Parts (Sheet 2 of 2)

MP MASTER
MA34152